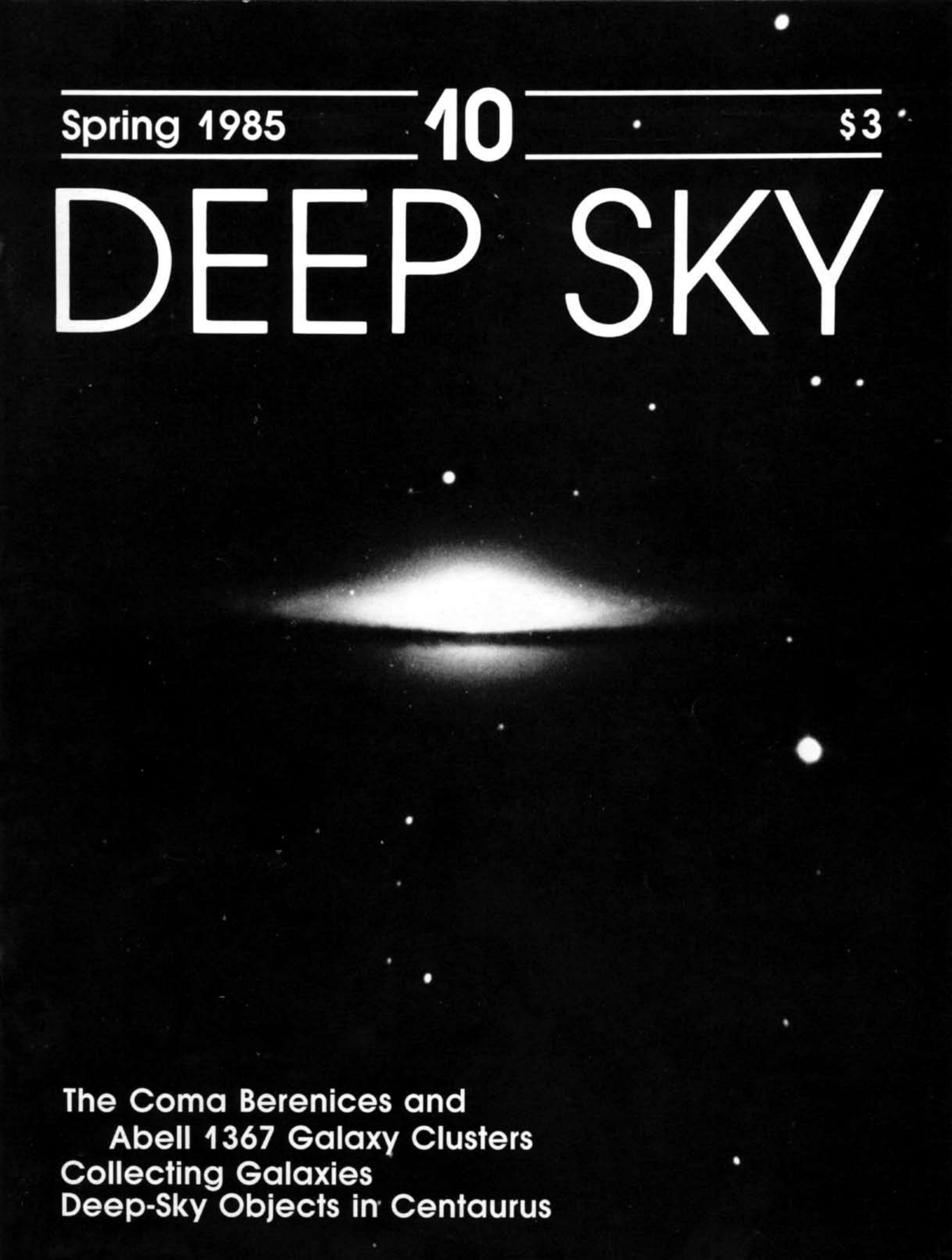
Spring 1985 10 $3

DEEP SKY



The Coma Berenices and
Abell 1367 Galaxy Clusters
Collecting Galaxies
Deep-Sky Objects in Centaurus

Letters to DSM

Sir, You Have the Wrong Cluster!

Dear Dave / I've really been enjoying the new *Deep Sky* magazine and anxiously await each issue. I believe there was an error in the caption of one of the photos published in the "Star Clusters in Cassiopeia" article in *DSM #8* on page 29. The photo labeled NGC 7788 and Harvard 21 actually shows NGC 7788 and NGC 7790. I've enclosed a photograph showing all three clusters properly identified.

One of my deep-sky projects is to photograph all of the clusters in Cassiopeia, and your article forced me to go back and shoot a few I wasn't aware of before. Thanks for an interesting issue.

Lee C. Coombs
1859 Ferrell Avenue
Los Osos, CA 93402

Lee C. Coombs

NGC 7790 (upper left center), NGC 7788 (center), and Harvard 21 (lower right).

Novae in the Andromeda Galaxy

Dear Sir / I read the article "All About M31" in the fall 1984 issue of *Deep Sky*. Based upon Brian Skiff's concluding remarks, I thought you might be interested in one of my experiences. Although I have been involved primarily with supernova searching, between November 1982 and March 1983 I searched for novae in M31 using a 12.5-inch f/6 Newtonian, a camera, and Tri-X film. Since I have no great love of guiding, developing, or maintaining darkroom chemicals, I kept the project simple by making short exposures and comparing them to Paul Hodge's *Atlas of the Andromeda Galaxy*.

Over a period of several months, I discovered one nova at magnitude 17.2, which showed on several frames, and detected another unconfirmed object. I thought I found a third nova, but the astronomer Leonida Rosino could not confirm it on 2-meter telescope plates taken two days before and after my sighting. After each event, I sent a telegram to Brian Marsden at the International Astronomical Union, who made the information public on the IAU's *Circulars*. Marsden told me that for novae, the observer must confirm a sighting for himself since others may not be able to respond in time.

The experiment concluded successfully and provided some valuable lessons in observational astronomy. Last winter I stopped hunting for novae in M31 to finish chart work for an atlas on supernova searching, to be published by Cambridge University Press in mid-1985.

I enjoyed the article, and will watch *Deep Sky* for more from Brian Skiff.

James Bryan
1601 Enfield Road, #1
Austin, TX 78703

Mr. Bryan / Many thanks for your thoughtful letter. On one hand, I'm chagrined that you've scooped me with your nova discoveries (I've just looked back through the IAU Circulars *and found your discovery announcements): on the other hand, I'm pleased my "prediction" that novae in M31 can be found with modest equipment is correct.*

I am among many who eagerly await publication of your supernova-hunting atlas. My own work for Cambridge, with Chris Luginbuhl, is just about finished — we're assembling the 700-pages of text and 2500-object catalogue and should be finished early this year.

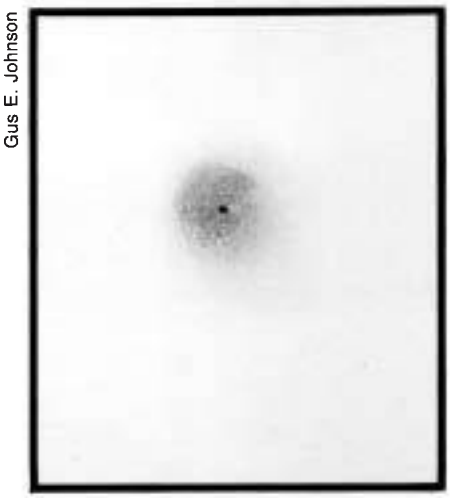
— Brian Skiff.

Viewing NGC 7023 in Cepheus

Dear Dave / I am glad to have resubscribed to *Deep Sky*. It is even better than before: Issues 7 and 8, that I have received so far, are really rich in what visual observers enjoy. In the article "Observing Low Surface Brightness Objects" (*Deep Sky #7*), you requested a sketch of the faint nebula NGC 7023 in Cepheus. The star around which the reflection nebula is visible appears on AAVSO charts for T Cephei, which lies less than a degree to the northeast. The nebulous star is comparison star 71, meaning that its magnitude is 7.1, but I suspect that it too is variable. (On January 15, 1982, for example, I estimated it to be at magnitude 6.0.)

I observed the nebula twice this autumn, first using my 6-inch Newtonian at 95x and more recently my 8-inch reflector at 48x. The view was essentially the same in both telescopes, save for a few faint field stars. I then tried 58x with a UHC filter and 40x with an Hβ filter, but the unfiltered view was best.

Gus E. Johnson



NGC 7023 viewed with an 8-inch scope.

Gus E. Johnson
RD 2, Box 67
Swanton, MD 21561

Coming or Going?

Dear Editor / My compliments on the fall issue. I have one question, however. In Brian Skiff's article on M31, he states that the arms are spinning toward us on the northeastern end. Robert Burnham, Jr. notes that radial velocity measurements show the northern tip to be *receding*, and Hans Vehrenberg also states that the northeastern section is moving away from us. Is Skiff's

DEEP SKY 10

The magazine for deep-sky observers and astrophotographers

Volume 3, Number 1
Spring 1985

Cover: M104, the Sombrero Galaxy in Virgo, photographed by Jack B. Marling; 24-inch f/15 telescope at f/6.5, hypered TP 2415 film, 30-minute exposure from Mauna Kea, Hawaii.

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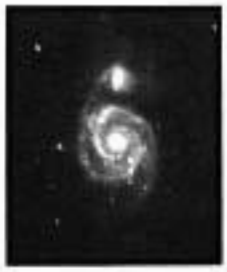

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6 The Coma Berenices and Abell 1367 Galaxy Clusters

by Brian Skiff

For sheer numbers of objects, observing a cluster of galaxies is a wonderful experience. Here lie several dozen galaxies within several degrees of sky, enabling backyard observers to "chalk up" many deep-sky objects in a short time, and study the visual appearance of a dense grouping of galaxies. The Coma Berenices galaxy cluster (Abell 1656) and Abell 1367 in Leo are two rich clusters offering much for observers. In this article, Brian Skiff of Lowell Observatory details the finest members of each group.

16 Collect a Galaxy!

by Jay Albert

Have you ever thought of collecting galaxies? With a little practice and a few dollars' worth of materials, you can make accurate and useful pencil sketches of the many galaxies littered across the spring sky. Sketches give you a record of your observation and do it more subtely than photography, which doesn't yield a "visual record" of what an object looks like in the eyepiece. Along with sketching tips, Jay Albert offers a portfolio of 13 fine drawings.

22 Deep-Sky Objects in Centaurus

by Jim Barclay

Although part of Centaurus is inaccessible to many Deep Sky *readers, the sky's half-horse, half-man Centaur holds a large number of galaxies and other deep-sky objects — 81 in all. DSM's correspondent "down under," Jim Barclay, surveys Centaurus' deep-sky objects and gives us a look, through descriptions, photos, and sketches, of some of the southern sky's best sights. Complete data for all objects appears in a table on page 28.*

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statement an error or does it indicate controversy?

Thanks for the magazine.

Steve Doriss
2731 Center Road
Novato, CA 94947

Dear Mr. Doriss / You are correct; Mr. Skiff made an error in stating that M31 is coming toward us on the northeastern end — its southwestern end (with NGC 206) is coming toward us. The material in the rest of the paragraph, however, is all correct.

— DJE.

By the Way, What's NGC 1?

Dear Dave / Occasionally a deep-sky object attracts attention, not because it is bright, but because it is unusual or curious — like the Horsehead Nebula, Stephen's Quintet, and the Crab Nebula. The Crab Nebula, the first object listed in Charles Messier's listing of deep-sky objects, is the remnant from a supernova explosion which occurred in the year 1054 A.D. The first object in J.L.E. Dreyer's *New General Catalogue*, however, appears to us as an ordinary faint spiral galaxy. It's nonetheless interesting simply because it is the first entry in the standard reference for deep-sky observers.

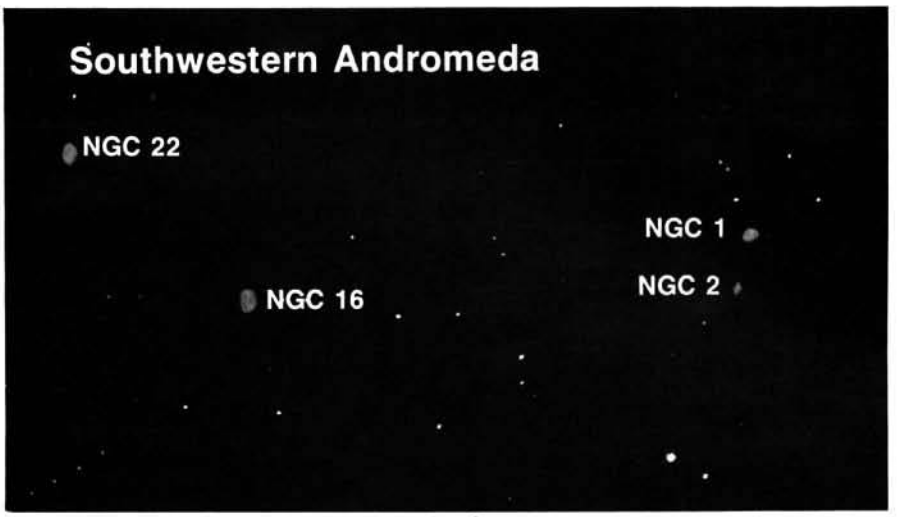
The easiest way to find NGC 1 is to first find the brighter nearby galaxy NGC 16. Plotted on Tirion's *Sky Atlas 2000.0*, NGC 16 lies about 80′ south and 10′ east of the 2nd magnitude star Alpheratz (Alpha [α] Andromedae). In an 8-inch scope, NGC 16 appears as a small and condensed 13th magnitude galaxy some 45″ across, with a moderately bright core. Another galaxy on the way to NGC 1 is NGC 22, which is a 15th magnitude object less than 20″ in diameter, lying 2′ south of a 10th magnitude star. (All but the largest backyard telescopes probably won't show NGC 22.) NGC 1 is located about 20′ west and slightly south of NGC 16. It is a magnitude 13.5 galaxy and measures about 30″ in diameter. A small triangle of faint stars lies to the northwest. Just 2′ due south of NGC 1 is NGC 2, a nearly-stellar magnitude 14.5 galaxy.

Here are the current data for these four galaxies, extracted from Gerard de Vaucouleurs' *Second Reference Catalogue of Bright Galaxies*: **NGC 1:** 0h08.3m, +27°43′ (2000), magnitude ∼ 13.4, diameter = 1.9′x1.5′, type = Sa(s)b:; **NGC 2:** 0h07.3m, +27°41′ (2000), magnitude ∼ 14.8, diameter = 1.4′x0.9′, type = Sa; **NGC 16:** 0h09.1m, +27°44′ (2000), V magnitude = 12.0, diameter = 2.1′x1.2′, type = SAB0⁻?; **NGC 22:** 0h09.8m, +27°51′ (2000), magnitude ∼ 14.9, diameter = ?, type = SB(s).

Early observations of NGC 1 were made by Heinrich Ludwig d'Arrest. The object was listed in Sir John Herschel's *General Catalogue* as GC 1, but today's backyard observers largely ignore it. Can we see some amateur photos and sketches of this little galaxy?

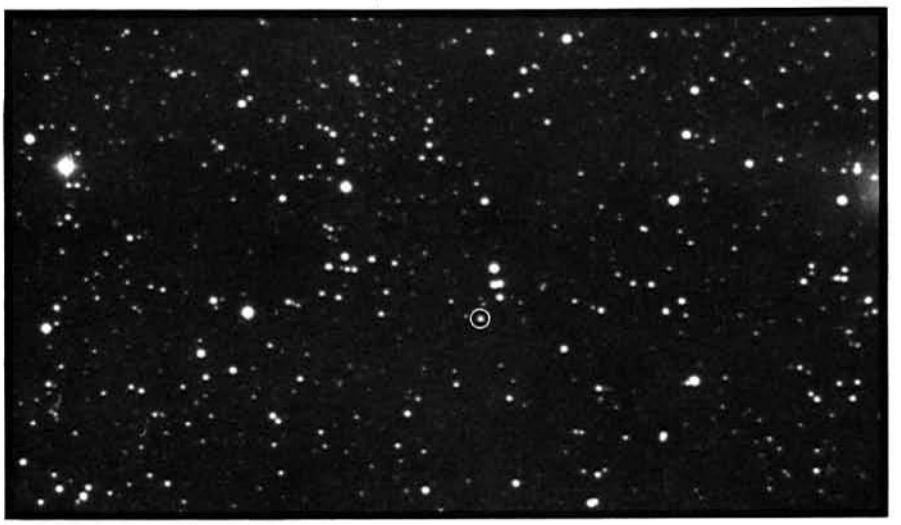
Dave Kratz
Dept. of Earth and Space Sciences
State University of New York
Stony Brook, NY 11794

Dave Kratz



The NGC 1 field sketched using an 8-inch telescope.

K. Alexander Brownlee



SS-433 (circled) photographed with a 16-inch telescope.

Needle in a Haystack

Dear Dave / I enjoyed seeing the coverage of the peculiar starlike object SS-433 in the winter issue of *Deep Sky*. The first time I attempted to find SS-433 was at the 1984 Texas Star Party. As I wandered through the telescope field and checked what was in the eyepieces, I found that most were aimed at Mars. I figured that I could see Mars from the more light-polluted east, so I tracked down a 14.5-inch telescope pointed at a deep-sky object about 13° above the southern horizon, the great globular Omega (ω) Centauri.

The telescope's owner — whose name I can't recall — was from Indianapolis. Rather needlessly, I asked him how Omega looked: "Beautiful!" Since I wanted to look at some fainter stuff, he let me take control of the telescope. By midnight, we turned the scope toward SS-433. Using a photo from the January 1982 *Deep Sky Monthly*, we located the two bright guide stars nearby. Soon after we found SS-433, but it was visible only with averted vision. Since the sky transparency and darkness were excellent (stars fainter than 7th magnitude visible to the naked eye), we estimated that SS-433 was at 16th magnitude.

After returning from the TSP, I sent Alexander Brownlee the coordinates for SS-433 and asked him to photograph it using a 16-inch f/5 reflector. A couple of weeks later, a package came which contained two 8″ x 10″ prints; his setting circles must be accurate, as SS-433 was almost exactly in the field's center! The photo, reproduced here, makes a good finder chart.

On August 30, some three months after the TSP, I decided to use the University of Louisville's 11-inch f/10 SCT to find SS-433 again. Starhopping from Delta (δ) Aquilae, I found the field and then switched to a 4.8mm Nagler eyepiece yielding 600x. This time it seemed brighter than at the TSP; perhaps magnitude 14.5.

Deep-sky observers armed with large scopes might enjoy hunting for this "needle in a haystack." The coordinates are: 19h 11.8m, +4°59′ (epoch 2000). Can SS-433 be spotted in a telescope under 10-inches' aperture?

Alan Goldstein
3430 Bryan Way
Louisville, KY 40220

Don't Ignore the Galaxies

Dear Sir / Thanks for the fantastic article about M31 in the fall issue of *Deep Sky*! As a telescope operator on the parallax program with our 20-inch refracting telescope, I usually pretty much ignore the galaxies; but I'm going to take another look at M31 from now on. Keep up the good work!

Joe Caruso
Van Vleck Observatory
Wesleyan University
Middletown, CT 06457

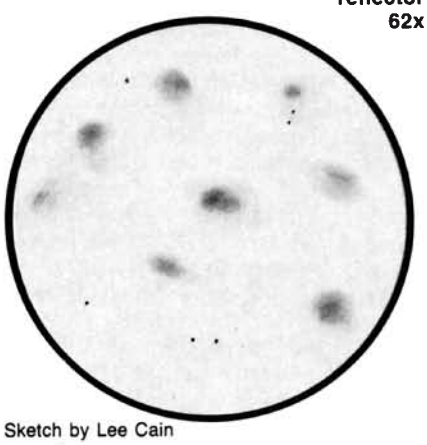
Field Full O' Galaxies

Dear Dave / Here's a sketch I made on January 5, 1984, of *eight* galaxies within the same field! I used a 13.1-inch f/4.5 binocular telescope with a 24mm Tele Vue eyepiece, was centered on the Virgo Cluster "mainline" near M84 and M86, and was surprised to easily spot six other patches of fuzzy light. I hope that other observers, when they stare at the center of the Virgo Cluster, will also see all eight objects.

Lee Cain
16206 Grassy Creek
Houston, TX 77082

Virgo Cluster

13.1-inch reflector 62x



Sketch by Lee Cain

Mount Kobau Experience of the First Kind

Dear Sir / I have been an amateur astronomer for the best part of three years now and am fast becoming a deep-sky fanatic. This year I attended my first star party, the Mount Kobau Star Party, which I hope will become an annual event. Mount Kobau is located in the Okanagan region of British Columbia, just 6.9 miles west of Osoyoos on Highway 3. It is a very dark site, and the intended spot for a four-meter telescope which was never completed due to financial problems. This year the Mount Kobau event drew a wide variety of telescopes, some as large as 20-inches in aperture. An astrophotography contest was held and judged by Leo Van der Byl and Jack Newton, both from Victoria, British Columbia.

Of all the deep-sky objects I looked at, the one that really impressed me was the Veil Nebula in Cygnus. I viewed it through a 10.1-inch Dobsonian with a UHC filter, and I could see color and bright knots of structure easily. It was a sight that converted me into a deep-sky enthusiast. I recommend that you attend this star party next year and enjoy the hot summer days and cool summer nights of Osoyoos. For more information, write: Mrs. Jackie Warrington, Site 16 Comp 30, RR 1, Winfield, British Columbia V0H 2C0.

Malcolm Scrimger
1278 Rockcrest Avenue
Victoria, British Columbia V9A 4W2

Hooray for Binoc's!

Dear Mr. Eicher / Hooray for the "Cainian" binocular! (*Deep Sky #7.*) Its design is basically so simple and the advantages are so obvious. Now, with inexpensive mirrors, this "MMT" will surely become an accepted genre. In the past decade, there have been many advances for astrophotographers. Large binoculars and high-tech filters now offer a similar leap for the visual astronomer.

Mark Harmond
12326 Red River Drive
Dallas, TX 75240

Inside View

Why Observe an Abell Cluster?

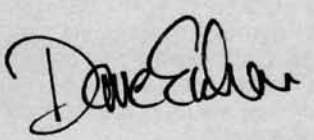
Just about every spring a number of deep-sky observers ask me why anyone should bother with looking at a cluster of galaxies. After all, most of the Abell clusters are distant, and therefore their member galaxies appear to be small and fuzzy. Gazing at a remote cluster of galaxies may require dark skies and a patient eye, but it can show you a large number and wide variety of galaxies grouped into one conveniently small area. Lowell Observatory astronomer Brian Skiff's article, beginning on page 6, will show you how to observe two of the most prominent galaxy clusters — Abell 1367 in Hercules and Abell 1656 in Coma Berenices.

Also in this issue are Jay Albert's story on "collecting galaxies" by making sketches of them. Few backyard telescopists know that sketching is a useful, enjoyable, and reliable way of recording observations, and that *good* sketching is not as difficult as it may seem. Next time you're under the stars, try sketching a few galaxies — the Herschels would be proud of you! Our correspondent "Down Under," Jim Barclay of Queensland, Australia, has compiled an article detailing deep-sky objects in Centaurus. Normally Centaurus is out of view for many of DSM's readers, but since it contains the best globular cluster, the best active galaxy, and the closest star to the Sun, it is well worth reading about — even if you can't actually see it "in person."

By the way, a word of caution to those of you who have ordered back issues of the old *Deep Sky Monthly*. I am moving across town during late February and early March; the back issues will likely remain "out of reach" until late March. I will make a giant mailing on April 1, so if you've ordered back issues recently, expect to get them by mid-April.

A final note: this issue almost didn't get out! At AstroMedia's annual mid-winter party — which celebrated the slim possibility that spring may come to Milwaukee, sooner or later — I suffered an accident and broke my left arm. Fortunately everything in *Deep Sky* 10 was finished — save for this editorial, which I am typing with one hand. Now, if I can just avoid slipping on the ice and breaking my *right* arm. . . .

Warm regards,



Dave Eicher
Editor

The Coma Berenices and Abell 1367 Galaxy Clusters

by Brian Skiff

Want to find a lot of deep-sky objects without a lot of searching? Try looking for nearby groups and clusters of galaxies. These range from incredibly dense clouds of very faint fuzzies down to groups of only a handful of spirals and ultimately simple pairs of galaxies orbiting about a common center, or perhaps colliding.

That galaxies cluster was recognized by the turn of this century, even before the "spiral nebulae" were known to be outside the Milky Way. Charles Messier himself found three dozen galaxies in what is now called the Virgo cluster. Photographers began turning up the brightest rich galaxy clusters around 1900. In 1906 astronomer Max Wolf in Heidelberg, Germany "discovered" the Coma Berenices galaxy cluster on plates he took with a 16-inch astrograph. Though several dozen galaxies had already been catalogued there mostly by visual observers, Wolf's photographs showed for the first time many hundreds of cluster members.

Before World War II, there was evidence not only that perhaps all galaxies belonged to groups or clusters, but also that the clusters themselves were lumped together. Harlow Shapley at Harvard found this "metagalactic structure" — as he termed it — on southern hemisphere wide-field survey plates. Edwin Hubble, working in the north at Mount Wilson, counted galaxies in about 1300 tiny fields photographed with the 60- and 100-inch telescopes. He concluded that this could not be explained by a random clumping of isolated "field" galaxies, but that galaxies must occur predominantly in groups and clusters.

Galaxy-counting continued into the 1960s, when the Lick Observatory survey was completed by Donald Shane and Carl Wirtanen. They assayed about a *million* galaxies to beyond magnitude 18 in the northern two-thirds of the sky, and called attention to prominent "clouds" of galaxies and much larger superclusters. Using the National Geographic-Palomar Observatory *Sky Survey* (POSS), George Abell of UCLA made a catalogue of 2700 rich clusters of galaxies. Palomar's Fritz Zwicky catalogued about 10,000 clusters of all kinds north of the celestial equator. Taken together, these surveys conclusively showed that galaxy clusters are far more numerous than almost anyone had believed.

The Abell catalogue is now the only widely used list because it includes the easily studied populous objects. He included clusters which have more than 50 members no more than two magnitudes fainter than the third-brightest cluster galaxy. Abell also restricted membership to those galaxies within an angular diameter that varied with the magnitude of the brightest cluster galaxies. This second criterion kept the circle containing the cluster to a fixed size in space, approximately 6 megaparsecs.

Though sophisticated classification schemes exist, galaxy clusters can be separated into three broad categories: "regular" or "compact," "intermediate," and "irregular" or "open."

The photographs you see in magazines of tremendous aggregations of galaxies all portray regular clusters. These symmetrical objects are usually nearly circular in outline, and are often dominated by one or a few supergiant elliptical galaxies located at the center. The component galaxies include very few spirals. The well-known Coma Berenices and Corona Borealis clusters fall into this class.

The open galaxy clusters are unconcentrated and show an irregular outline. Here spirals are as numerous as elliptical and lenticular types. The nearby Virgo cluster and the Hercules galaxy cluster (Abell 2151) are typical. The various branches of the Virgo cluster extending into Leo, Canes Venatici, and elsewhere are typical of irregular clusters, where several nuclei or "subclusters" are present.

The intermediate clusters are just that: the constituent galaxies are somewhat concentrated, but generally not in a spherical form — lenticular galaxies are most numerous. The Perseus cluster (Abell 426), whose brightest galaxies are arranged in a string, is an example.

The true size, shape, and population of any cluster of galaxies are difficult to determine. If most galaxies are in clusters or groups, how can we tell the boundary between a cluster and the "field"? Do galaxies simply thin out and merge into the adjacent group? Look at the Coma cluster: the literature says it's 12° across; Thomas Noonan reanalyzed Zwicky's own data and found a diameter of only 200 arcminutes (3.3°); and Abell showed most of the Coma galaxies lie in a 5.4°x4.8° oval! These seeming discrepancies arise from how the "background" of galaxies was determined. Even using redshifts to pick out members is not conclusive. The range of velocities is large even for near-certain members due to the motions of individual galaxies. In the Coma cluster, the average redshift is about 7000 km/sec, but galaxies with velocities ranging from about 5000 to 9000 km/sec belong to the group.

As more and more velocities were measured in the Coma cluster, Stephen Gregory and Laird Thompson found in 1978 that a band of galaxies at the same redshift arcs westward from the Coma group to another rich, but irregular cluster (Abell 1367) about 20° away in Leo. The two clusters lie near opposite ends of a supercluster stretching perhaps 100 megaparsecs. No wonder the edge of the Coma cluster is hard to pin down!

These two clusters make a nice pair for visual observing, as they contain some of the richest fields of galaxies in the sky. The Coma cluster, also known as Abell 1656, is the classic rich, well-

concentrated cluster containing two supergiant elliptical galaxies at its center and a few spirals on the periphery of the densest region. The central density of galaxies is about ten times higher than that for areas a few degrees away. Several of the individual galaxies are radio sources, and there is a general enhancement of the radio background, which is evidence for a gaseous intracluster medium. The cluster is also an X-ray source.

Less spectacular, Abell 1367 is an irregular cluster containing a mix of spiral and elliptical galaxies scattered in small clumps. It is a diffuse source of radio radiation; several discrete X-ray sources have been located within the cluster. Two of the latter were recently shown to be quasars near the brightest central galaxy, NGC 3842 (see *Deep Sky 9*, page 38). The two quasars are in the data list for the cluster as GP 945 and GP 872; though not accessible visually (they're magnitude 19), it shouldn't be difficult for amateurs to photograph them with modest equipment.

My visual observations of these objects in February and June 1984 were made with the U.S. Naval Observatory's 24-inch Cassegrain telescope stopped down to an equivalent 12½-inch aperture. A 24mm Konig eyepiece gave about 225x. Its finder, a 5-inch refractor, served also for views of the brighter objects. Additional observations were made with 6- and 10-inch Newtonians.

The Coma Cluster

The brightest galaxies in the Coma cluster are **NGC 4889**, just east of the center of the cluster, and **NGC 4874**, slightly fainter, 9.2′ away to the west. Both are visible in the 5-inch refractor at medium power. NGC 4874 is more difficult to view, appearing as a poorly-concentrated roughly circular patch. A magnitude 12.5 star lies 2′ southwest. A magnitude 7 star only 6.5′ north of the galaxy interferes somewhat with viewing here and in larger apertures. With the 12½-inch, NGC 4874 is about 1.5′ across and roughly circular, but many tiny galaxies nearby make for a seemingly irregular outline. The outer regions have a moderate even concentration; the core arises in a slight, sharp condensation 20″ across, but there is no distinct nucleus.

NGC 4872 is the closest in a virtual cloud of tiny objects around NGC 4874. Lying at about 50″ in p.a. 200° from NGC 4874, the 12½-inch shows a little star-like point with a weak halo no more than 15″ in diameter. **NGC 4871**, 1.3′ west of NGC 4874, is a small concentrated spot similar to NGC 4872, but somewhat fainter. NGC 4873, at 1.6′ in p.a. 340°, seems larger and less concentrated than the others. The well-defined portion is about 15″ across, elongated a bit east-southeast/west-northwest. **IC 3998**, 2.3′ away in p.a.

Galaxies in Abell 1656

12h59m43s, +27°58′14″ (2000)

Type	GMP	GP	NGC/IC	RA (2000) Dec	Mag.	SB	Size
E	4943	888	—	12h57m20s +27°29′42″	14.5	—	0.3′ x 0.2′
SA0⁻	4928	886	NGC 4839	12h57m22s +27°30′00″	12.4	14.6	4.2′ x 2.1′
E1:	4829	856	NGC 4840	12h57m30s +27°36′42″	13.5	12.2	0.6′ x 0.6′
SA0 pec	4822	857	NGC 4841A	12h57m30s +28°28′42″	12.7:	13.3	1.7′ x 1.7′
E0 pec	4806	854	NGC 4841B	12h57m32s +28°29′00″	13.3:	14.0	1.3′ x 1.3′
E0	4749	850	NGC 4842A	12h57m33s +27°29′42″	13.9	12.4	0.6′ x 0.4′
E3:	4792	849	NGC 4842B	12h57m33s +27°29′12″	15.0	12.7	0.4′ x 0.3′
Sa: sp	4471	763	NGC 4848	12h58m04s +28°14′30″	13.6	13.5	1.8′ x 0.6′
SA0	4315	726	NGC 4850	12h58m19s +27°58′07″	14.1	14.9	1.6′ x 1.6′
E	4313	727	NGC 4851	12h58m19s +28°09′01″	14.6	—	0.6′
E	4308	722	IC 839	12h58m20s +28°09′13″	15.3	—	0.5′
E	4230	710	—	12h58m28s +28°00′55″	13.8	—	1.5′ x 1.5′
(R′)SA0⁻?	4156	690	NGC 4853	12h58m33s +27°35′49″	13.1	13.2	1.2′ x 1.0′
Sa?	4130	—	IC 3943	12h58m34s +28°06′49″	15.6[B]	—	0.7′
SB0	4017	660	NGC 4854	12h58m45s +27°40′31″	13.9	—	1.2′
SA0 sp	3997	655	IC 3946	12h58m46s +27°48′37″	13.9	12.9	1.0′ x 0.5′
SA0	3958	643	IC 3947	12h58m50s +27°47′07″	14.6	—	0.6′
SA0 pec sp	3896	627	IC 3949	12h58m54s +27°50′01″	14.1	12.6	1.3′ x 0.2′
S0?	3818	613	—	12h58m60s +28°13′31″	14.1	—	0.7′
SBb	3816	612	NGC 4858	12h58m60s +28°06′55″	15.0	12.4	0.4′ x 0.3′
E2:	3792	—	NGC 4860	12h59m02s +28°07′25″	13.5	13.2	1.0′ x 0.9′
SBa	3779	607	—	12h59m03s +27°38′43″	14.7	13.4	0.6′ x 0.5′
SA0	3761	602	IC 3955	12h59m04s +27°59′49″	14.3	—	0.9′
E	3739	595	IC 3957	12h59m04s +27°46′07″	14.5	—	0.4′ x 0.4′
SB0	3733	596	IC 3960	12h59m06s +27°51′19″	14.5	12.4	0.4′ x 0.4′
E3	3730	594	IC 3959	12h59m06s +27°47′02″	13.9	12.7	0.6′ x 0.6′
E2	3664	583	NGC 4864	12h59m11s +27°58′38″	13.6	12.1	0.6′ x 0.4′
SA0 sp	3660	580	IC 3963	12h59m11s +27°46′32″	13.5	12.7	0.6′ x 0.3′
S0	3656	575	—	12h59m12s +28°04′38″	14.4	12.5	0.4′ x 0.4′
E3	3639	575	NGC 4867	12h59m13s +27°58′14″	14.2	14.2	1.1′ x 1.1′
E6	3561	560	NGC 4865	12h59m18s +28°05′02″	13.3	13.4	1.4′ x 0.8′
E6	3510	544	NGC 4869	12h59m21s +27°54′38″	13.5	13.7	1.1′ x 1.1′
dbl galaxy	3418 4	534	—	12h59m23s +27°58′26″	—	—	0.6′
E6	3423	514	IC 3976	12h59m27s +27°51′02″	14.4	—	0.7′
SA0	3414	511	NGC 4871	12h59m28s +27°57′20″	13.9	12.1	0.5′ x 0.4′
SB0	3400	502	IC 3973	12h59m29s +27°53′02″	14.2	—	0.9′
SA0	3367	499	NGC 4873	12h59m30s +27°59′02″	14.2	13.1	0.8′ x 0.6′
SB0	3352	496	NGC 4872	12h59m32s +27°56′50″	13.7	13.7	1.0′ x 1.0′
E⁺0	3329	489	NGC 4874	12h59m34s +27°57′32″	11.9	14.0	2.7′ x 2.7′
SA0	3296	477	NGC 4875	12h59m36s +27°54′26″	14.7	—	0.7′
E5	3201	452	NGC 4876	12h59m42s +27°54′44″	14.2	12.2	0.4′ x 0.4′
SB0	3170	442	IC 3998	12h59m45s +27°58′26″	14.7	—	0.6′ x 0.4:′
Sa?	3165	441	—	12h59m45s +27°42′38″	13.9	—	1.2′ x 0.3′
SB0	3073	423	NGC 4883	12h59m54s +28°02′02″	14.3	—	0.4′ x 0.3:′
SA0⁻	3055	416	NGC 4881	12h59m56s +28°14′50″	13.5	13.5	1.0′ x 1.0′
E0	2975	385	NGC 4886	13h00m02s +27°59′15″	13.9	13.5	0.8′ x 0.8′
S0	2946	376	—	13h00m04s +27°58′45″	14.9	—	0.9′
E0	2940	368	IC 4011	13h00m04s +28°00′15″	15.0	—	0.4′ x 0.4:′
E3	2922	360	IC 4012	13h00m06s +28°04′45″	14.8	—	0.4′ x 0.3:′
E⁺4	2921	362	NGC 4889	13h00m06s +27°58′39″	11.4	13.4	3.0′ x 2.1′
E0	2839	332	IC 4021	13h00m13s +28°02′33″	14.9	12.2	0.3′ x 0.3′
SA0	2815	329	NGC 4894A	13h00m14s +27°58′03″	13.9	—	0.8′
E pec	2798	322	NGC 4898A	13h00m15s +27°57′21″	13.6	—	0.9′
SA0 pec sp	2795	326	NGC 4895	13h00m16s +28°12′09″	12.8	13.4	2.3′ x 0.9′
E pec	2794	319	NGC 4898B	13h00m16s +28°12′09″	15.3	—	0.6′
SB0	2727	297	IC 4026	13h00m16s +27°57′27″	14.7	—	0.5′ x 0.4:′
S0⁻ pec	2629	—	NGC 4896	13h00m20s +28°02′51″	13.7	13.4	1.3′ x 0.7′
Sdm:	2559	251	IC 4040	13h00m28s +28°20′45″	14.7	14.1	1.1′ x 0.6′
E3	2541	245	NGC 4906	13h00m36s +28°03′33″	14.2	—	0.6′ x 0.5:′
E6	2535	241	IC 4041	13h00m38s +27°55′27″	14.5	13.7	0.7′ x 0.7′
SB0	2516	237	IC 4042	13h00m39s +27°59′51″	14.3	—	0.6′ x 0.5:′
SB(r)b	2441	215	NGC 4907	13h00m41s +27°58′21″	13.4	13.9	1.5′ x 1.3′
E4	2440	217	IC 4045	13h00m47s +28°05′27″	13.9	12.6	0.7′ x 0.5′
E5	2417	208	NGC 4908	13h00m50s +28°02′33″	13.5	13.7	1.1′ x 1.0′
S0	2413	209	—	13h00m49s +28°21′57″	13.8	—	0.8′
Sm?	2393	198	—	13h00m52s +27°47′03″	15.3	—	0.6′ x 0.4′
E0	2390	195	IC 4051	13h00m52s +28°00′27″	13.4	13.8	1.3′ x 1.1′
SAB(r)bc	2374	192	NGC 4911	13h00m54s +27°47′27″	12.8	13.1	1.3′ x 1.2′
E	2252	167	—	13h01m07s +27°49′10″	14.8	—	0.8′
(R⁻)SA(r)0?	2157	149	NGC 4919	13h01m16s +27°48′34″	13.7	13.7	1.4′ x 0.8′
SB(rs)ab	2059	132	NGC 4921	13h01m23s +27°53′10″	12.1	14.0	2.7′ x 2.4′
(R⁻)SA(r)0⁻?	2000	120	NGC 4923	13h01m29s +27°50′52″	13.6	13.8	1.3′ x 1.2′
S0 sp	1853	94	—	13h01m44s +28°05′46″	14.2	—	0.6′
SA0⁻	1750	64	NGC 4926	13h01m52s +27°37′35″	12.9	13.4	1.4′ x 1.3′
SA0⁻	1715	58	NGC 4927	13h01m55s +28°00′29″	13.6	—	1.2′
S0 pec?	1616	44	NGC 4926A	13h02m05s +27°38′59″	14.4	13.5	0.8′ x 0.6′

Column 1: revised Hubble galaxy types from the *Second Reference Catalogue of Bright Galaxies*, by G. and A. de Vaucouleurs and H. Corwin, Univ. of Texas Press, 1976. **Column 2:** catalogue numbers from the J. Godwin, N. Metcalfe, and J. Peach galaxy listing in *Monthly Notices of the R.A.S.*, **202:**113+microfiche (1983). **Column 3:** catalogue numbers from the J. Godwin and J. Peach galaxy listing in *Monthly Notices of the R.A.S.*, **181:**323 (1977). **Column 4:** catalogue number in the *Revised New General Catalogue* by J. Sulentic and W. Tifft, Univ. of Arizona Press, 1973, the *Index Catalogues*, and additional listings. **Column 5:** coordinates for epoch 2000.0. **Column 6:** V magnitudes unless superscript B, meaning blue magnitude. **Column 7:** mean surface brightness in magnitudes per square arcminute. **Column 8:** angular size in arcminutes.

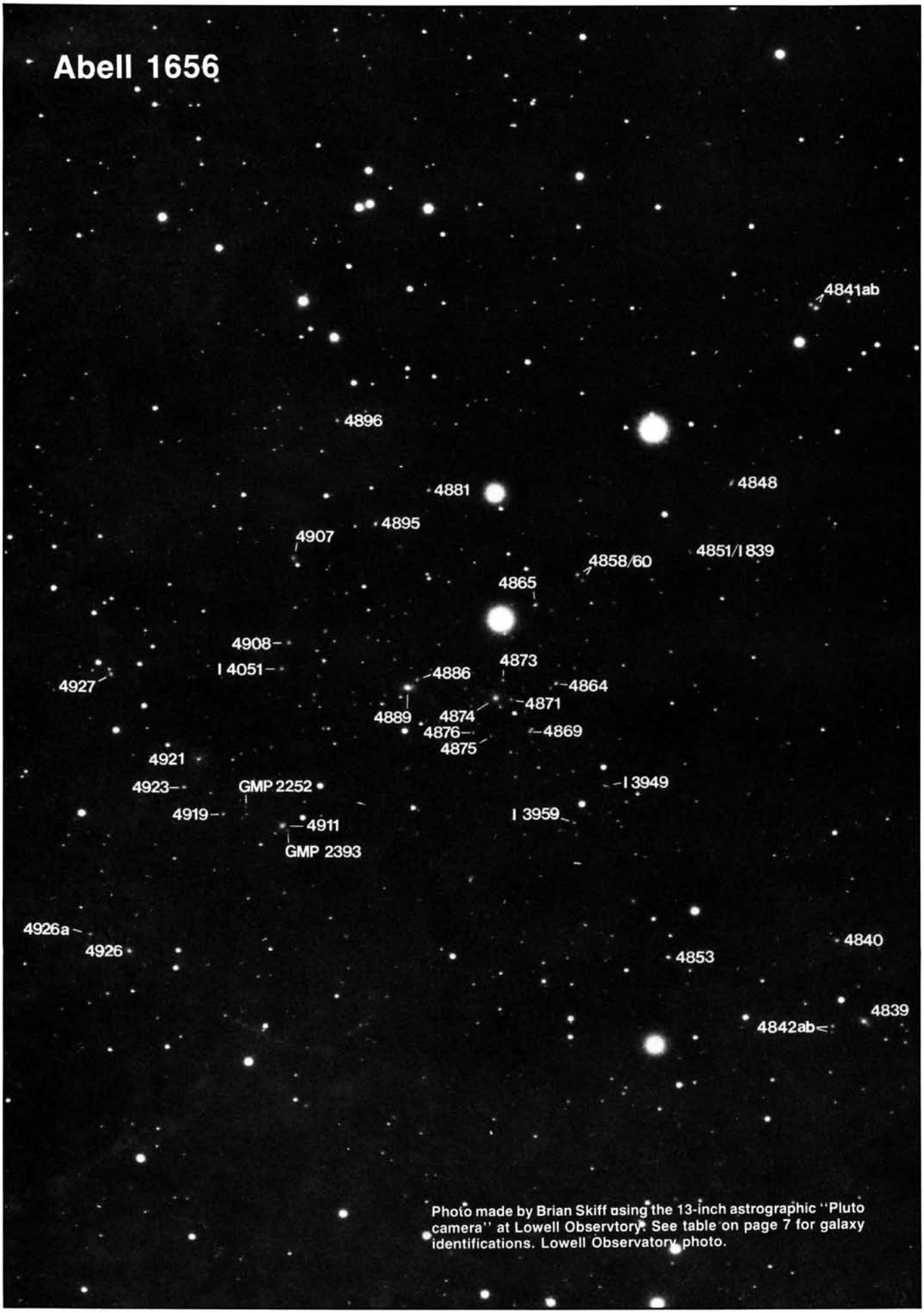


Photo made by Brian Skiff using the 13-inch astrographic "Pluto camera" at Lowell Observtory. See table on page 7 for galaxy identifications. Lowell Observatory photo.

75°, is fairly faint and moderately concentrated, but only 10″ diameter.

NGC 4869 is a brighter galaxy located 2′ southwest of the magnitude 12.5 star a similar distance southwest of NGC 4874. In the 12½-inch it is larger and brighter than NGC 4872, and has a magnitude 13.5 star 17″ northwest of its center. The halo is 30″ across, just reaching this star, and is not strongly concentrated.

The supergiant elliptical NGC 4889 is distinctly brighter than NGC 4874 in the 5-inch. The light is well concentrated to a faint stellar nucleus. The 1.5′ halo seems elongated east/west, but a magnitude 13.5 star 1′ southeast makes this impression uncertain. The elongation is nevertheless more certain in larger apertures. With the 12½-inch, however, the center is more broadly concentrated. At 225x I discerned a mottled area in the west side: this is the tiny galaxy **GMP 2976**, only 28″ from the center.

Opposite NGC 4889 from the magnitude 13.5 star is **NGC 4886**, typical of the tiny objects scattered throughout the cluster. A little brighter is **NGC 4898**, a binary galaxy 2.5′ southeast of NGC 4889. I noted in the 12½-inch that this object has a fairly high surface brightness. The 25″x15″ patch is elongated in p.a. 70°, and seems to have little surrounding halo. I could not definitely detect the fainter nearby **NGC 4894**, nor separate the two components of NGC 4898 (combined V=13.4).

Spread around the two central ellipticals are many more galaxies. My attention was drawn to several pairs and strings of objects. Well away from the center to the southwest, **NGC 4839** was not difficult to view in the 5-inch, lying between a magnitude 12 star 2.6′ northeast and a magnitude 13.5 star 2.3′ southwest. The small diffuse glow is weakly brighter across the center. It stands out as one of the larger cluster galaxies with the 12½-inch, reaching to 1.1′x0.7′ in p.a. 60°. The halo has a flat brightness profile in the outer regions, then becomes suddenly brighter across the core, which contains a faint but distinct stellar nucleus. Photographs suggest that the elongation observed here may be due to a faint galaxy (**GMP 4943**) superimposed on the southwest side 25″ from center, and a magnitude 15 star in the northeast side. The close pair **NGC 4842AB** lies only 2.6′ of NGC 4839.

Toward the northwest side of the cluster is another close pair of galaxies, **NGC 4841AB**. Only 30″ apart, these two objects are in contact in the 12½-inch. The southwestern component, NGC 4841A, is the larger and brighter of the two. At 255x it is about 40″ in diameter, slightly elongated east-west, with a strong, even concentration to a conspicuous 8″ core. The northeastern component is similarly concentrated, except that the core is a bit more so, but smaller (substellar), and thus appears fainter than that of NGC 4841A.

NGC 4848 is distinctly elongated with the 12½-inch (it is one of the few spirals in the cluster), reaching to 48″x30″ in p.a. 60°. The lenticular halo has a moderate, even concentration toward the center. **NGC 4860** is of similar size and brightness, but nearly circular. Its light is evenly concentrated to an indistinct core and faint nucleus. I could

Photo by John B. Priser using the 61-inch astrometric reflector at the U.S. Naval Observatory's Flagstaff station. U.S.N.O. photo.

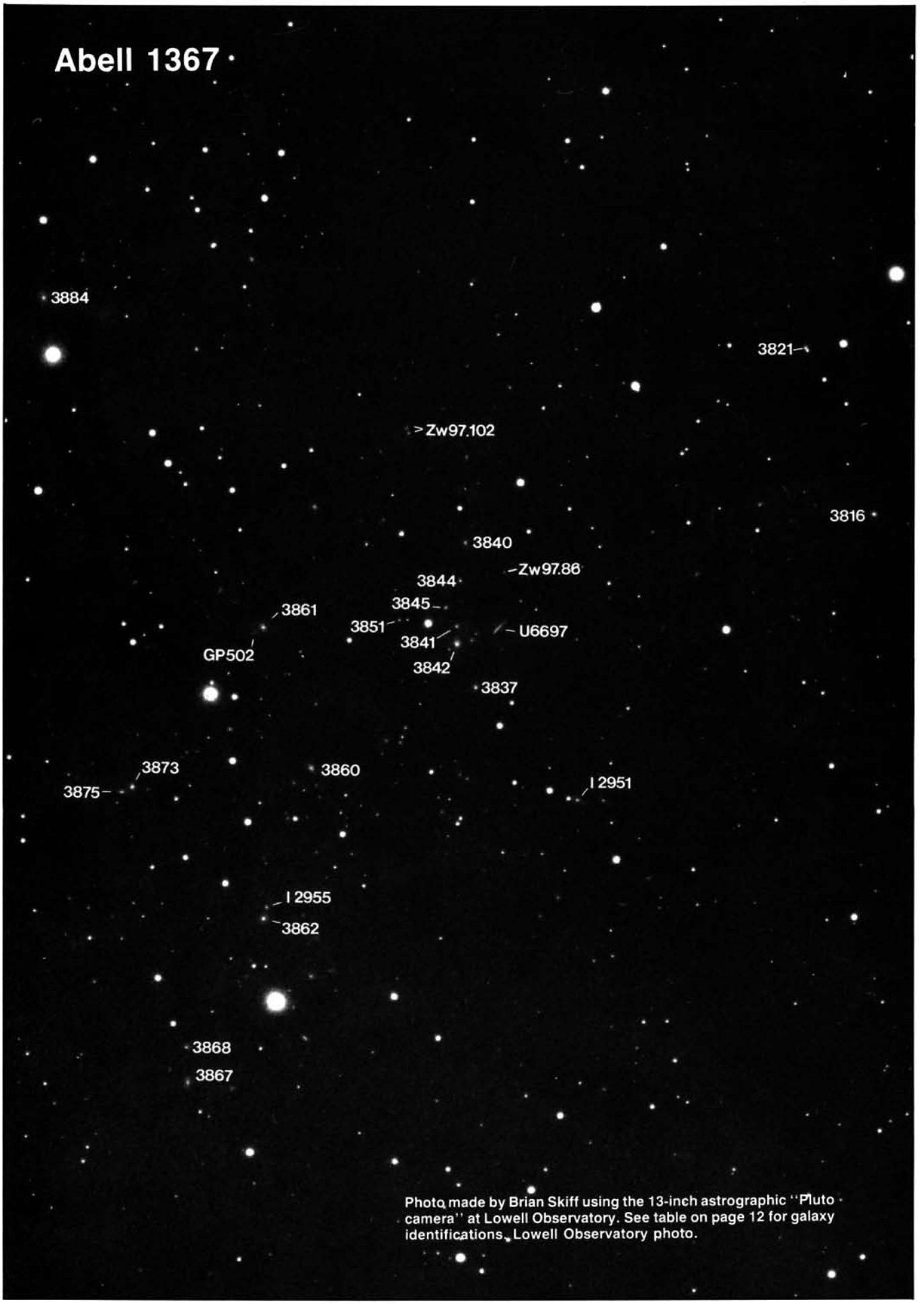


Photo made by Brian Skiff using the 13-inch astrographic "Pluto camera" at Lowell Observatory. See table on page 12 for galaxy identifications. Lowell Observatory photo.

just make out **NGC 4858** at high power using averted vision.

NGC 4865 lies only 2.8′ northwest of the bright 7th magnitude star. The galaxy is still easy for the 12½-inch. The concentrated halo is about 30″ long, extending east-southeast/west-southwest. Its faint companion, **GMP 3656**, 1.4′ west-southwest, is 20″ across, a diffuse unconcentrated glow difficult for the 12½-inch telescope.

In the field immediately west of NGC 4874 are three small objects. **NGC 4864** is the easiest: in the 12½-inch it is about 30″ across and somewhat elongated toward its companion **NGC 4867**, in about p.a. 120°. The halo is well concentrated to a substellar core. Tiny NGC 4867, about 35″ away, is a sharply concentrated substellar spot clearly separable from NGC 4864. Nearby **IC 3955** forms the western corner of a triangle including a magnitude 15 star 45″ east-northeast, and the galaxy pair NGC 4864/NGC 4867. It is very small, only 10″ across, with a very faint stellar nucleus.

Riding just above the two big guys near the center of the cluster is **NGC 4883**. In the 12½-inch it is a diffuse, moderately-low surface brightness patch 15″ across. Farther north, **NGC 4881** is the first of three brighter galaxies in a line. It appears as a 20″ circular glow, well concentrated to a sharp, conspicuous stellar nucleus. Next is the spindle **NGC 4895**. It is conspicuous in the field by its shape, a 25″ x 10″ oval elongated in p.a. 150°. The halo has a moderately-high surface brightness and is well concentrated toward the center. Last in the string of three is **NGC 4907**, a moderately faint object for the 12½-inch. The 30″ halo is roughly circular, and weakly concentrated to a faint but distinct stellar nucleus. A magnitude 13 star lies 40″ southwest of center.

Southwest of the center of the cluster is a group of bright spirals. **NGC 4911** is visible in the 5-inch refractor at 60x, forming the southeastern member of a string including two magnitude 12.5 stars within 4′ northwest. With the 12½-inch it is circular, 1.3′ diameter, and broadly concentrated. The companion **GMP 2393** appears to be on the edge of the halo (35″ from center). It is very faint but well-defined, yet unconcentrated toward the center. A magnitude 14.5 star is visible off the halo of NGC 4911, 45″ southeast of its center.

NGC 4919 is a fainter object also with a companion. About 15″ across, it is well concentrated to a stellar nucleus. **GMP 2252**, 1.9′ away in p.a. 290°, is a very faint and concentrated substellar spot. The brightest of the group of spirals is **NGC 4921**, visible in the 5-inch as an unconcentrated 2′ patch with a magnitude 13 star about 3′ northeast. In the 12½-inch the unconcentrated low surface brightness halo is elongated in p.a. 120°, reaching 1.2′x0.8′. The core is brighter, however, and a stellar nucleus is clearly visible. **NGC 4923**, 2.6′ southeast, seems only a little fainter than NGC 4921, but it is much smaller. The diffuse 30″ halo is moderately concentrated to a bright substellar center.

Abell 1367

NGC 3842 is the brightest galaxy in this cluster. Unlike the Coma *lucidae*, this object is of normal luminosity, not a dominating supergiant. In the 5-inch

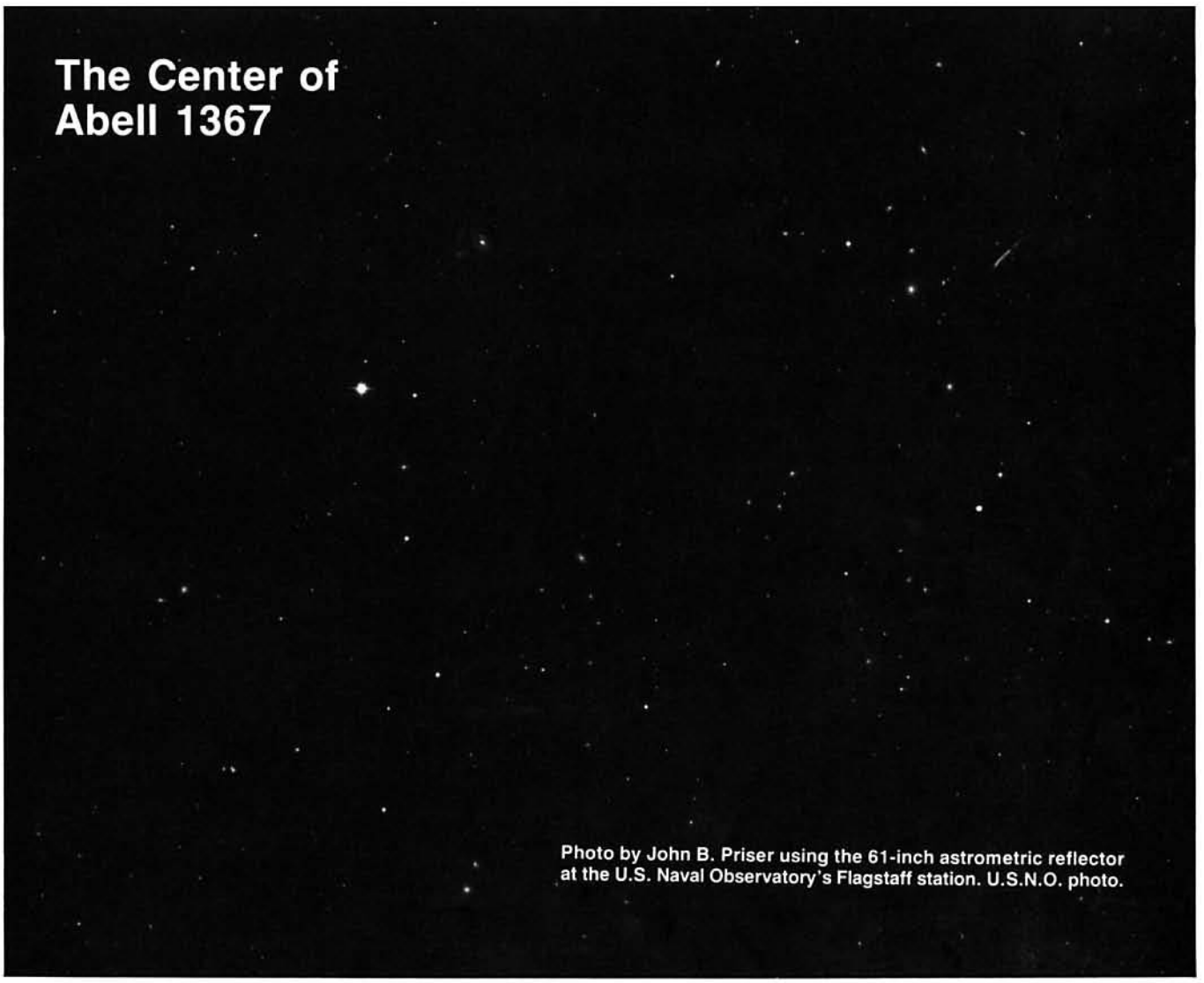


Photo by John B. Priser using the 61-inch astrometric reflector at the U.S. Naval Observatory's Flagstaff station. U.S.N.O. photo.

Galaxies in Abell 1367

11h44m17.5s, +19°50′30″ (2000)

Type	GP	Object	RA (2000) Dec	Mag.	Size
S0 pec	1522	NGC 3816	11h41m49s +20°06′21″	13.6	2.2′ x 1.3′
(R)SAB(s)ab	1451	NGC 3821	11h42m10s +20°19′03″	13.8	1.6′ x 1.3′
S	1388	Zw 97.72	11h42m46s +20°02′03″	15.0	1.3′ x 0.6′
S0	1290	Zw 97.74	11h42m60s +20°05′15″	15.4	0.8′
Sb	1270	UGC 6680	11h43m03s +19°39′03″	15.5	1.3′ x 0.8′
S0	1169	IC 2951	11h43m26s +19°45′03″	15.0	1.5′ x 0.8′
S	1129	Zw 97.83	11h43m32s +19°37′45″	15.2	1.2′ x 1.0′
E	1083	Zw 97.85	11h43m38s +19°36′21″	15.7	0.2′ x 0.2′
S0	1030	Zw 127.40	11h43m45s +20°16′27″	15.3	—
S0	1015	Zw 97.86	11h43m48s +20°02′27″	15.7	0.6′
Sm	993	UGC 6697	11h43m51s +19°57′57″	14.3	1.7′ x 1.4′
E	949	NGC 3837	11h43m58s +19°53′39″	14.2	1.0′ x 0.9′
E	946	Zw 97.90a	11h43m58s +19°57′27″	17.3	0.2′ x 0.2′
QSO	945	—	11h43m58s +19°56′51″	19.1	0.3′
E	941	Zw 97.90b	11h43m59s +19°57′15″	15.8	0.3′ x 0.3′
Sa	926	NGC 3840	11h43m60s +20°04′39″	14.7	1.2′ x 0.7′
S0	924	Zw 97.92	11h44m01s +19°46′51″	15.5	1.3′ x 0.4′
S0/a	915	NGC 3844	11h44m02s +20°01′45″	14.9	1.5′ x 0.4′
E	900	NGC 3841	11h44m03s +19°58′21″	15.0	1.6′
E3	899	NGC 3842	11h44m03s +19°57′03″	13.3	1.2′ x 1.0′
S	874	NGC 3845	11h44m07s +19°59′51″	15.1	0.8′ x 0.4′
QSO	872	—	11h44m07s +19°57′39″	18.9	0.3′
E	857	Zw 97.99	11h44m09s +19°44′20″	15.7	1.2′
E	800	Zw 97.102a	11h44m18s +20°13′02″	15.6	0.8′ x 0.5′
S	792	Zw 97.102b	11h44m19s +20°13′26″	15.2	0.4′ x 0.3′
pec	780	Zw 97.101	11h44m20s +19°50′32″	15.3	0.6′ x 0.5′
E	771	NGC 3851	11h44m22s +19°58′50″	15.2	0.3′ x 0.3′
S pec	768	Zw 97.110	11h44m22s +19°49′32″	15.5	1.0′
S0	692	Zw 97.112	11h44m32s +20°04′38″	14.9	1.3′ x 0.3′
Sc	616	UGC 6719	11h44m47s +20°07′32″	14.6	1.3′ x 0.9′
Sab	605	NGC 3860	11h44m49s +19°47′44″	14.5	1.3′ x 0.7′
S	603	NGC 3857	11h44m50s +19°32′02″	15.1	1.0′ x 0.5′
S pec	591	NGC 3859	11h44m52s +19°27′20″	14.9	1.1′ x 0.3′
S	579	Zw 97.125	11h44m55s +19°46′38″	15.6	0.7′ x 0.3′
S0	573	Zw 97.124	11h44m57s +19°43′56″	15.3	0.8′
(R′)SAB(r)b	532	NGC 3861	11h45m04s +19°58′26″	14.0	2.4′ x 1.5′
E	531	IC 2955	11h45m04s +19°37′14″	15.2	0.4′ x 04′
E0	521	NGC 3862	11h45m05s +19°36′26″	13.7	1.6′ x 1.6′
S	509	UGC 6725	11h45m06s +20°26′20″	14.5	1.8′ x 1.5′
S	502	—	11h45m07s +19°58′02″	15.6	0.8′ x 0.3′
E	459	Zw 97.131	11h45m15s +19°50′44″	15.1	0.4′ x 0.4′
S	427	Zw 127.47	11h45m24s +20°19′32″	14.6	0.5′ x 0.4′
S	398	NGC 3867	11h45m30s +19°24′02″	14.6	1.7′ x 0.7′
S0	397	NGC 3868	11h45m30s +19°26′44″	14.8	1.2′ x 0.4′
E	319	NGC 3873	11h45m46s +19°46′26″	14.2	1.1′ x 1.0′
S0	319	NGC 3875	11h45m50s +19°46′02″	14.8	1.1′ x 0.3′
SA(r)0/a	217	NGC 3884	11h46m13s +20°23′26″	14.0	1.9′ x 1.5′

Column 1: revised Hubble galaxy types from the *Second Reference Catalogue of Bright Galaxies*, by G. and A. de Vaucouleurs and H. Corwin, Univ. of Texas Press, 1976. **Column 2:** catalogue numbers from J. Godwin and J. Peach galaxy listing in *Monthly Notices of the R.A.S.*, **181**:323 (1977). **Column 3:** catalogue number in the *Revised New General Catalogue* by J. Sulentic and W. Tifft, Univ. of Arizona Press, 1973; the *Index Catalogues*, Nilson's *Uppsala General Catalogue*, or Zwicky's *Catalogue of Galaxies and Clusters of Galaxies*. **Column 4:** coordinates for epoch 2000.0. **Column 5:** photographic B (blue) magnitudes, primarily from Zwicky's *CGCG*. **Column 6:** angular size in arcminutes.

refractor it appears as a conspicuous diffuse spot 2.7′ southwest of a magnitude 11 star. At high power the 12½-inch shows it in the midst of a field crowded with fainter galaxies. The 50″ halo contains a small indistinct core and stellar nucleus. **GP 941**, a tiny elliptical companion at 1.1′ in p.a. 280°, is visible in the 12½-inch as a concentrated substellar spot with a magnitude 15 star 35″ northwest of it. I found no trace of an even smaller companion to this galaxy, **GP 946**. **NGC 3841** lies 1.3′ north of NGC 3842. The 12½-inch shows a conspicuous well-concentrated glow here, typical of the fainter E-type galaxies in the cluster.

A few arcminutes to the west is perhaps the most striking object in the cluster, **UGC 6697**. Photographs suggest that it is an edge-on late-type spiral like NGC 55 in Sculptor, but some distortion by NGC 3842 is probably also evident. The 12½-inch shows the 1.2′x0.15′ spindle elongated in p.a. 135°. The brightness along the major axis is approximately uniform except at the very tips.

In the same field to the south, **NGC 3867** seems only a little fainter than NGC 3842. In the 12½-inch the 30″ halo is not quite as well concentrated as the brighter galaxy. To the north, **NGC 3844** and **NGC 3840** appear similar in the 12½-inch. The first is slightly elongated northeast/southwest, while NGC 3840 is a bit larger and better concentrated than NGC 3844. A very faint "anonymous" galaxy, **GP 1015**, could be seen only with difficulty.

Off at the northwest edge of the cluster is **NGC 3821**, located about 3′ east of a magnitude 11 star, and visible in the 5-inch as a hazy spot. At first sight in the 12½-inch it looked like a magnitude 13 double star: the galaxy is the northeastern component, 16″ away from a star of similar magnitude. A very faint halo of the galaxy just envelopes the star, making it about 30″ across. The light is somewhat less concentrated than the star, and a small granular core is visible in the center.

GP 792 and **GP 800** make a difficult pair of galaxies for the 12½-inch, lying only 27″ apart. The two patches are in contact at 225x, the southern being substellar, while the companion is visible only intermittently with averted vision.

One of the larger objects in Abell 1367 is **NGC 3860**, easily visible in the 5-inch refractor at 60x. The 12½-inch shows that the broadly concentrated halo is elongated slightly northeast/southwest. **UGC 6719**, about 20′ north, is practically a clone of NGC 3860.

Another relatively large object is **NGC 3861**, which has a fainter galaxy apparently projected on it — **GP 502**. They are visible as a single diffuse patch in the 5-inch. The glow is nearly 1′ across in the 12½-inch, a plain fuzz with

a small sharp center. The companion (50″ from the center in p.a. 115°) is not distinguishable as a separate object, but merely adds to the fuzz on that side of the brighter object.

NGC 3862 is about the second brightest galaxy in the cluster, and it too has a close companion. The brighter object is an easy target for the 5-inch, while the 12½-inch shows both NGC 3862 and **IC 2955**, 55″ away in p.a. 345°. NGC 3862 is 45″ diameter with a moderately strong but azonal brightness profile; a stellar nucleus is occasionally visible. IC 2955 is fainter but not difficult to see, and clearly separated from NGC 3862. It is only 20″ across and rather more diffuse.

A final pair of galaxies is **NGC 3873** and **NGC 3875**, separated by about 50′. Both are visible at low power in a 10-inch telescope. At high power, the 12½-inch showed NGC 3873 as clearly nebulous, and is elongated a bit southeast/northwest. NGC 3875 is similar to a field star nearby to the southeast, but becomes a well-concentrated galaxy with attention.

* * *

I drew the information in the tables from a wide array of sources. For both clusters, identifying numbers are given for every object according to the photometric surveys by Godwin and collaborators. NGC or IC identifiers are given for most galaxies. The GMP numbers in Coma refer to the giant 6700-entry catalogue of Godwin, Metcalfe, and Peach. The GP numbers (from an earlier study by Godwin and Peach) provide a cross-reference to the discussion in the Webb Society *Handbook*, volume 5. Amazingly, no NGC or IC ambiguities are present in Coma! In Abell 1367, Nilson (in the *Uppsala General Catalogue*, UGC) calls N3841 what all other catalogues designate NGC 3845, and I've followed the majority opinion here. For Abell 1367, objects without an NGC or IC number are given designations where possible from the UGC (Uxxxx) or from Zwicky's *Catalogue of Galaxies and Clusters of Galaxies* (CGCG) in the form: ZwXX.XXX.

Positions were derived from the X,Y coordinates given in the GMP or GP catalogues, and are nominally accurate to two arcseconds. The additional precision is quite justified here, particularly for the Coma cluster, where many objects have the same right ascension to one second of arc.

In the Coma cluster, most of the galaxy types are from the *Second Reference Catalogue of Bright Galaxies* (RC2) by Gerard de Vaucouleurs and collaborators. In Abell 1367 they are a hodgepodge from the RC2, UGC, plus a few of my own from inspection of the POSS and large-scale plates. Dimensions are from the RC2 or from the UGC and MCG (*Morphological Catalogue of Galaxies*, by Boris Vorontsov-Velyaminov and collaborators) converted to the system of the RC2. Single figures are diameters from the GMP/GP catalogues, *not* on the standard system, and are "ballpark" figures listed only as a general guide.

Total V magnitudes are given for almost all Coma galaxies; about half are from the RC2. Godwin and Peach give V_{25} (brightness within the magnitude 25 per square arcsecond isophote) for many additional galaxies. These can be approximately corrected to V_t (total magnitude) using information in the RC2. After doing so, I compared the magnitudes for 28 objects having magnitudes listed in the RC2. The mean difference (a few hundredths of a magnitude) is negligibly small, though the scatter is rather larger than that given for the same galaxies in the RC2. Thus I have used the RC2 values when available, and the converted GP magnitudes otherwise (with no special mark). When dimensions are also available, the mean surface brightness magnitude can be calculated, and this is listed in the last column.

The GP magnitudes in Abell 1367 cannot be transformed yet to the standard system because there is little published UBV photometry for these galaxies. Until more definitive results are available, I'll stick with Zwicky's CGCG photographic magnitudes except for objects not listed by him, which come directly from GP. It's important to remember that the Abell 1367 magnitudes are photographic "blue" values, whereas the Coma data are "visual."

Selected Bibliography

Listed below are a few basic articles relevant to the Coma and Abell 1367 clusters, and to galaxy clusters generally. The review articles in the book-series *Annual Reviews of Astronomy and Astrophysics* are emphasized: these are written by leaders in the field, are thorough, and give exhaustive references to more specialized literature. They are also more likely to be found in city and college libraries than even the most common professional journals.

George O. Abell. 1975. "Clusters of Galaxies," in *Galaxies and the Universe*, volume 9 of "Stars and Stellar Systems," Gerard P. Kuiper, ed. University of Chicago Press, Chicago. (The best introductory review for amateurs.)

Neta A. Bahcall. 1977. "Clusters of Galaxies," in *Annual Reviews of Astronomy and Astrophysics*, **15**:505. (Thorough, up-to-date review; but not light reading.)

Alan Dressler. 1984. "The Evolution of Galaxies in Clusters," in *Annual Reviews of Astronomy and Astrophysics*, **22**:185. (Tour-de-force article on the next step: are galaxies in rich clusters different? And what happens to them?)

J.G. Godwin, N. Metcalfe, and J.V. Peach. 1983. "The Coma Cluster. I. A Catalogue of Magnitudes, Colours, Ellipticities, and Position Angles for 6724 Galaxies in the Field of the Coma Cluster." *Monthly Notices of the R.A.S.*, **202**:113 and microfiches.

J.G. Godwin, and J.V. Peach. 1977. "Studies of Rich Clusters of Galaxies. IV. Photometry of the Coma Cluster." *Monthly Notices of the R.A.S.*, **181**:323. (V_{25} magnitudes for 923 galaxies.)

J.G. Godwin, and J.V. Peach. 1982. "Photometry of the Cluster of Galaxies A1367." *Monthly Notices of the R.A.S.*, **200**:733 + microfiche. (Blue and red magnitudes for 1561 galaxies.)

Stephen A. Gregory, and Laird A. Thompson. 1978. "The Coma/A1367 Supercluster and Its Environs." *Astrophys. Journ.*, **222**:784. (Redshift survey showing the existence of this supercluster.)

Jan H. Oort. 1983. "Superclusters." *Annual Reviews of Astronomy and Astrophysics*, **21**:373. (Observationally-oriented review.)

C.D. Shane. 1975. "Distribution of Galaxies," in *Galaxies and the Universe*, volume 9 of "Stars and Stellar Systems," Gerard P. Kuiper, ed. University of Chicago Press, Chicago. (Summary and maps of the Lick survey and what it could mean.)

Brian Skiff is an astronomer at Lowell Observatory in Flagstaff, Arizona. His first book on observing will be published by Cambridge University Press in 1985. His last article in DEEP SKY *was "All About M31," in* DSM #8.

Small Scope Showcase

Spring's Bright and Varied Galaxies

by David H. Levy

If there indeed is a time for every purpose under heaven, then spring is the time for galaxies. A close look at any good star atlas will tell you that, but of course the real challenge is to get outside on a chilly spring evening and revel in the hundreds of galaxies that you can see through even a small telescope.

Let's begin with that atlas on a cloudy night, preferably *Sky Atlas 2000.0*, which shows the galaxies as little ovals plotted against the stars. And let's turn to Chart 2 which shows Ursa Major. Galaxies seem to pour out of the bowl of the Dipper, surrounding it in all directions, but especially to the south. In nearby Coma Berenices, even a beginner's eye can appreciate the obvious grouping of galaxies. Here in Coma is the northern end of the largest "megaclustering" of galaxies that we have ever encountered.

Look a bit further. Leo is also filled with galaxies. And Virgo — just look at all of them! If someone had randomly splattered the atlas with red ink, the effect would be about the same — they are everywhere!

NGC 4565 in Coma Berenices is the finest edge-on spiral galaxy in the sky. It is visible in binoculars as a slender needle of nebulosity. Photo by K. Alexander Brownlee.

This megacluster, known informally as the Coma-Virgo cloud, is so large and varied that it offers a fine sampling for every size telescope. In fact, for a small telescope Coma-Virgo may offer more than its neighbor Ursa Major, as the galaxies appear more condensed and easier to identify.

So much for atlas-scanning on a cloudy night; now let's use it, with telescope, moonless sky, warm clothes, and a dark-adapted eye. All kidding aside, you do need eyes that are adapted to the sky. Leaving a brightly-lit room and then looking into the eyepiece of your telescope is like having partial blindness; you won't see much of anything to begin with. Instead, just look up at the stars for 15 or 20 minutes. Gradually you'll experience your personal twilight as more and more stars appear. You can't rush into the galaxies, you must approach them reverently with a trained and adapted eye.

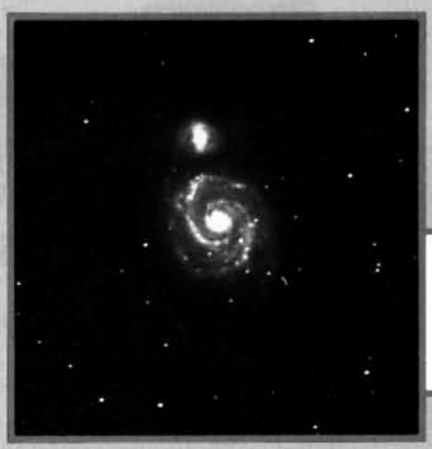
First, find Coma Berenices. On a good night from even a suburban sky, some of the stars of "Berenice's hair" should be noticeable as a large ethereal fuzz. From a dark location in the country you can see the constellation clearly.

But it's not the stars that really merit our attention tonight. Instead we want to see the dim spiral galaxies that lie far behind them. Take your telescope, insert a low-power eyepiece, and sweep through the area, counting the fuzzy patches you find. At a suburban location you'll be able to spot at least a few. If you have an 8-inch telescope or larger, you should pick out several galaxies, and notice that not all have the same shape — some are larger, some look round, others appear flat and narrow. There are two reasons for this difference in appearance. First, galaxies themselves differ in shapes. And second, we observe them at different angles. Some galaxies we see face on — they can simply appear round. Others we examine edge-on and they look linear.

M64 typifies a spiral galaxy seen nearly face-on. Called the "Black-Eye Galaxy" because of a massive dust cloud that dominates the central hub, it is at 8th magnitude and is bright and condensed enough that you should have little or no trouble finding it. You will need a dark sky to make out the dust

M64, the famed "Blackeye Galaxy" in Coma Berenices, is easily visible in any telescope. Its dusty namesake requires a 6-inch or larger scope to be seen. Photo by David Healy.

M65 (bottom) and M66 (top) are visible together in a low-power field of view. M65 has loose, knotty arms, while M66 shows a smoother, more oval disk. Photo by Lee C. Coombs.



M51, the Whirlpool Galaxy in Canes Venatici, is one of the best galaxies in the sky. Its little companion is NGC 5195, a small irregular galaxy interacting with the big spiral. Photo by Jim Riffle.

cloud, however.

In contrast, **NGC 4565** is a fine example of a spiral galaxy we view edge-on. It's not a Messier object, a hint that you'll need well-adapted eyes to see it. But what a surprise when you find it! It's loooong! It looks a bit like a pencil with a fat center. Our own Galaxy might look like this if we saw it from the right vantage point. The more aperture and darker sky you use on it, the better the view you'll get. If you look closely with an 8-inch you may be able to spot a dark band that crosses the galaxy; this is the central dust lane that many spirals have, but which is particularly evident in this fine galaxy.

Like M64, NGC 4565 is probably about 20 million light-years away, but it is fainter, shining at 10.5 magnitude. You may have difficulty finding NGC 4565 if you are using a telescope of less than 6-inches aperture — or if your sky is brightened by light pollution or moonlight. But I encourage you to try anyway, even with a 6- or 8-inch, because it is challenging and well worth the search.

Near the tail of Leo, two rather bright galaxies reside. **M65** and **M66** are a beautiful pair of spirals, positioned at a sharp angle to each other. They lie close to third-magnitude θ Leonis, so that with a good star chart you should have little trouble finding them. After all, Messier found them with his little 2-inch! Again, these are for dark moonless nights, when even a 6- or 8-inch telescope should reveal them nicely. From your own observations, how do these two galaxies differ from each other and from NGC 4565?

Let's continue by moving back toward Ursa Major, where lots of interesting galaxies are lurking. Just 3.5° southwest of the end star in the Dipper's handle is one of the most dramatic spiral galaxies in the entire sky: **M51**, known as the Whirlpool Galaxy. About 35 million light-years away, this system is about the same size physically as M31, the Andromeda Galaxy. Remarkable all by itself, the system is even more interesting because a small satellite galaxy (**NGC 5195**) seems attached to its north spiral arm. Although they are gravitationally related, NGC 5195 may not be in physical contact with M51.

Any spring tour of the galaxies worthy of the name must include **M81** and **M82** in Ursa Major. M81 is a bright version of a "prototypical" galaxy, with some of its spiral structure visible if you use an 8-inch or larger telescope. Its neighbor M82 looks at first glance like an edge-on spiral — and was once thought to be exploding. Astronomers now think it is a peculiar and irregular galaxy that is undergoing vigorous bursts of star formation.

The final galaxy we'll look at is our own, or at least selected portions of it. In a sense, our own Galaxy is the toughest one of all to study since we live inside it. Although spring is not a good time to see the rich starfields of the Milky Way, we can at least admire some of the bright star clusters that inhabit our galactic neighborhood. **M44**, more commonly known as the Beehive or Praesepe Cluster, lies in Cancer and is a group of some 200-plus stars slightly over 500 light-years away. The cluster is bright enough that you can see it easily as a misty spot with your unaided eye on a moonless night. Binoculars will resolve it and with a wide-field telescope you can see a cornucopia of stars. Have you ever noticed how different star clusters offer different patterns? Some seem to consist of stars arranged in a little arc. M44 seems — to me at least — to be organized in triangles.

From the Beehive, let's move into Canes Venatici — where **M3**, one of the most spectacular globular clusters in the sky, shines in all its glory. Ten billion years old, M3 is also one of the oldest objects belonging to our Galaxy. Unlike galaxies, which are usually difficult or impossible to observe from the city, M3 is close enough that we see it as a starry mass that is occasionally detectable even from a light-polluted city sky.

And as a final treat, stay up late. By 2 or 3 a.m., the broad central plane of our Galaxy will be well up in the east: the run of Milky Way heading south from Cygnus through Aquila and Serpens down to its grand finale (for us in the northern hemisphere, at least) in Scorpius and Sagittarius. More about *that* deep sky in the next *Deep Sky*.

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Collect a Galaxy!

by Jay Albert

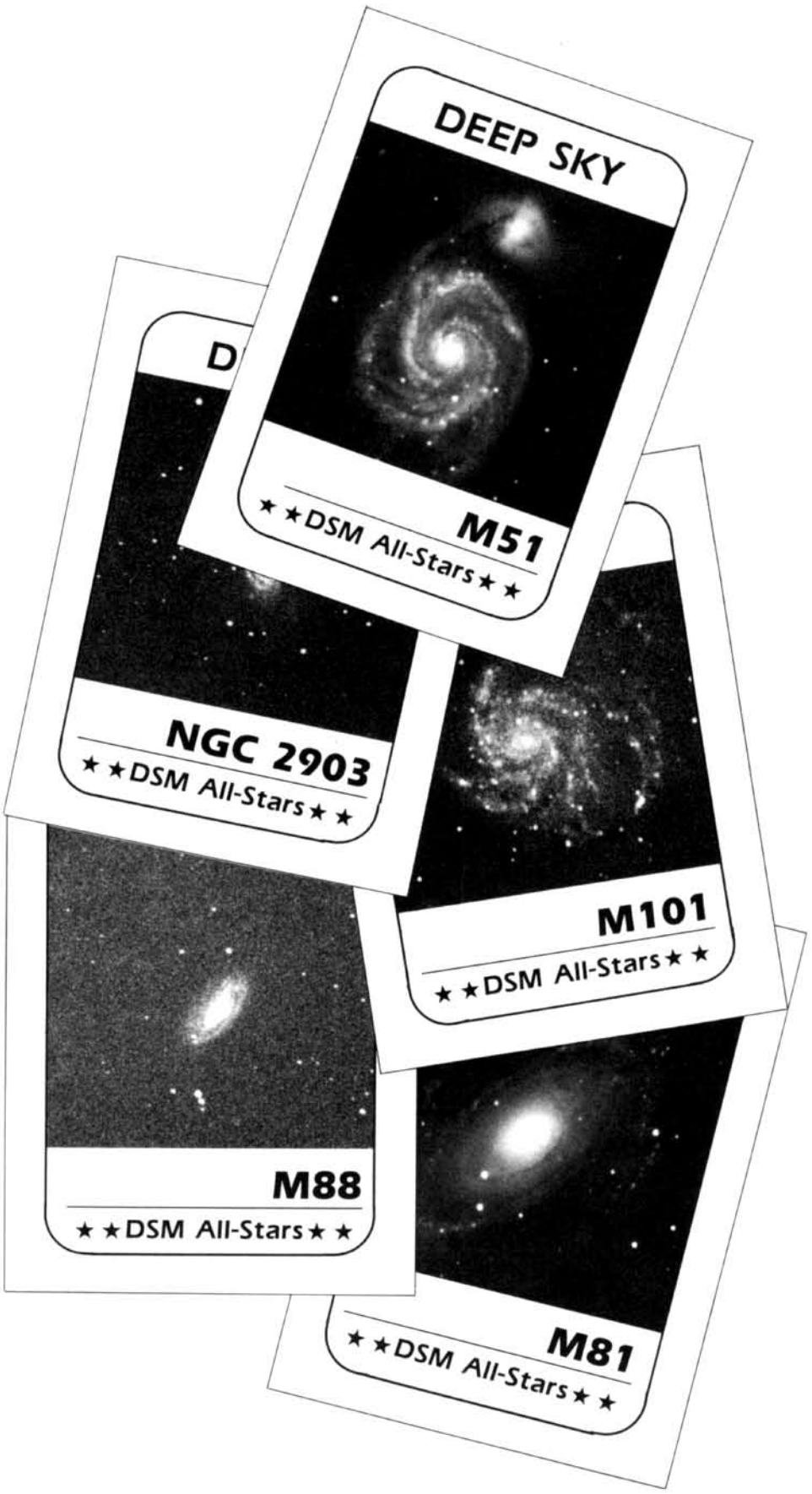
Fantastic! There's no Moon and the sky is transparent to the naked-eye limit. The seeing is steady and the Beehive is bright. Your eye resolves several stars in the Coma Berenices cluster. At the scope, you find elusive M101 easily. This time you see not only its round relatively-bright middle, but the huge extended disk as well. Although the spjral arms are lost, you can see knots of greater density that hint at the structure of this realm of stars.

The sight is so magnificent it seems to draw you into the telescope. The more you look, the more you seem to see. The wonder and peacefulness of the view makes you feel a part of the universe. Your problems and disappointments shrink to their proper perspective. It's for transcendent moments like these that you became an amateur astronomer, and you'd give nearly anything to capture this moment to enjoy again.

So why don't you?

"Well," you say to yourself, "getting into astrophotography is no simple matter. First of all, a five-minute quickie polar alignment that's good enough for visual observing won't do for deep-sky photography. I'll need a precision polar finder or a permanent pier, or I'll just have to work harder. My equatorial mount and drive alone aren't good enough. I'll need a declination drive and a dual-axis drive corrector. I'll need a guidescope or off-axis guider, with an illuminated reticle eyepiece. I'll need a camera adapter and a light-pollution filter larger and more expensive than the one that screws into my eyepieces. Maybe I should get a photo-visual telecompressor to reduce my exposure time — or buy a cold camera. And then there's film . . . and a hypering kit. Oh, *forget it!*"

Whoa, take it easy! Why let the problem determine your options? You can still capture that feeling of awe — and you don't need photography to do it.



The Three-Step Sketch

sequence by David J. Eicher

1. Apply pencil graphite in rough shape of object.

2. Smooth with finger or blending stump and add detail to nebulosity.

3. Add field stars from brightest to faintest, carefully measuring positions.

The alternative is sketching. It's simple, inexpensive, and above all, it lets you look at what you want to look at — not some dull guide star. You'll also be able to record objects *as you see them*, which is very different from what comes out in your photographs — if anything comes out at all. By observing and sketching, you'll also improve your powers of observation.

Let's examine some aids and hints for observing galaxies, the materials you'll need for sketching (you probably have some of them already), and sketching techniques. (Although I'm discussing galaxies, just about all of what I say applies to nebulae, too.) Don't be intimidated. You don't have to be an artist to sketch a galaxy — personally, I can't draw a straight line! So relax and enjoy yourself.

Observing Hints

The first step in collecting galaxies is knowing when it's not worth the bother. Here in central New Jersey, the suburban murk ensures that poor conditions are the norm. Nevertheless, on good nights I can see magnitude 5.5 stars with the naked eye. If I can't see stars that faint, even with averted vision, I'll look at the planets or double stars instead. Contrast is important and each season has appropriate naked-eye tests:

Spring — size and brightness of the Beehive (M44), and brightness and stars resolved in the Coma Berenices cluster.

Summer — brightness of the Milky Way and amount of internal detail resolved (e.g., Great Rift, M24 and Scutum star clouds, M8).

Fall — size and brightness of M31, Double Cluster in Perseus, and the fall Milky Way.

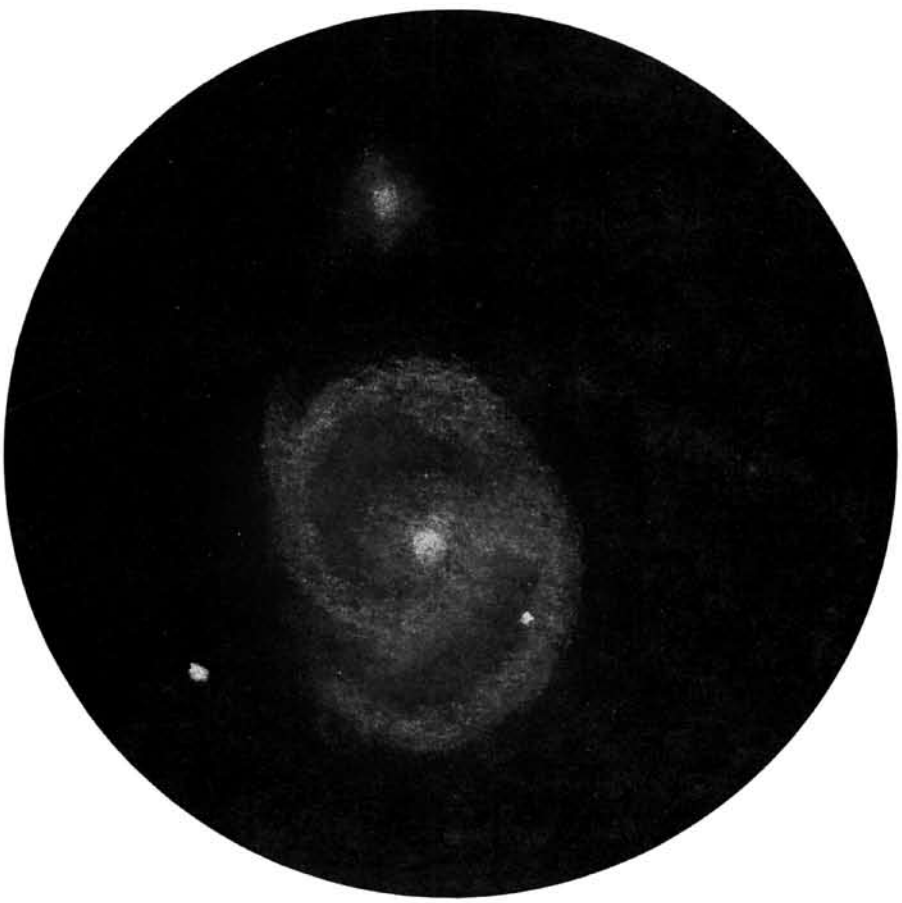
Winter — brightness of the winter Milky Way and visibility of M42.

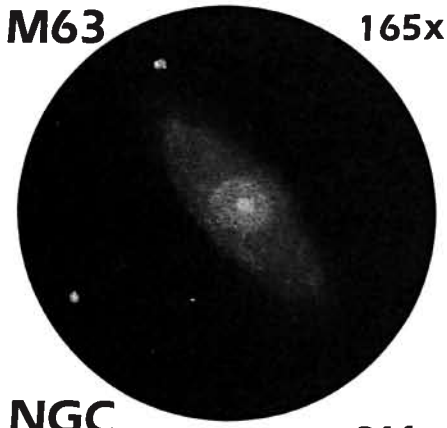
Remember to get dark-adapted before you start. I usually sit in a darkened room for 10 minutes before I go to check sky conditions. I'll dark-

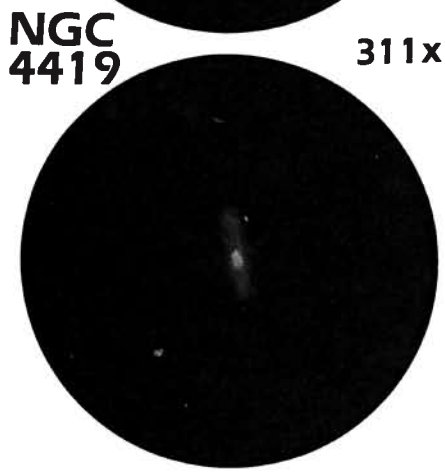
A Gallery of Eyepiece Impressions

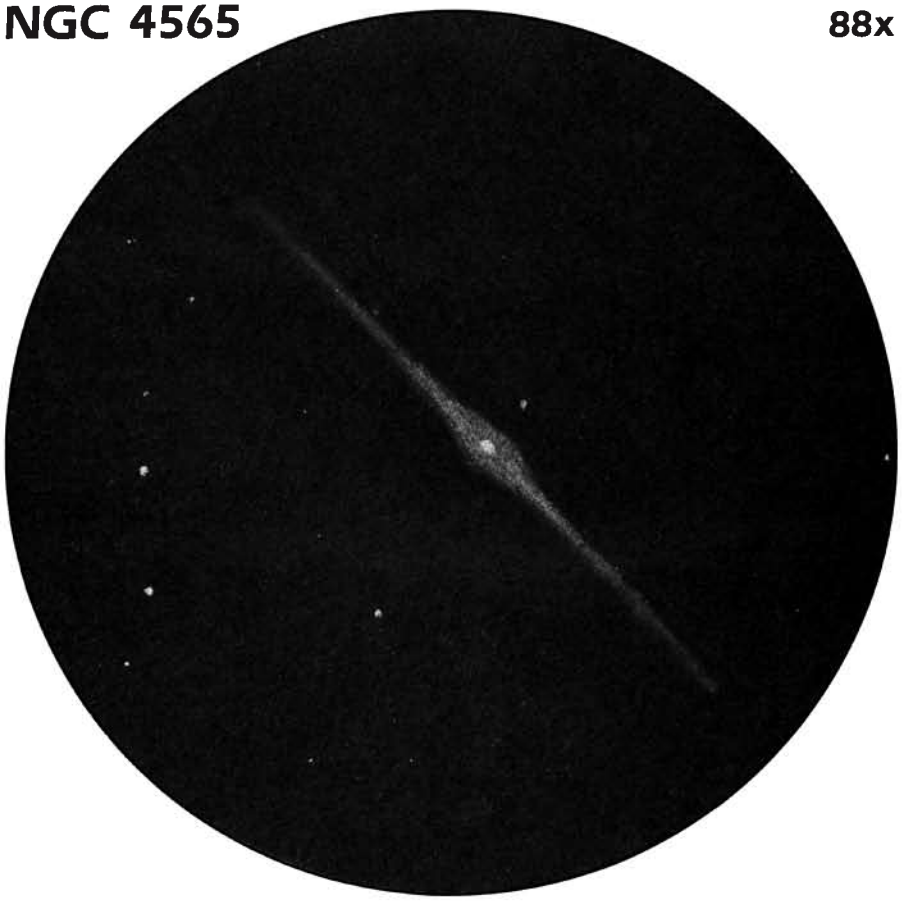
The following collection of telescopic sketches made by the author, with a 6-inch reflector, show galaxies' wide range of forms.

M51 **165x**









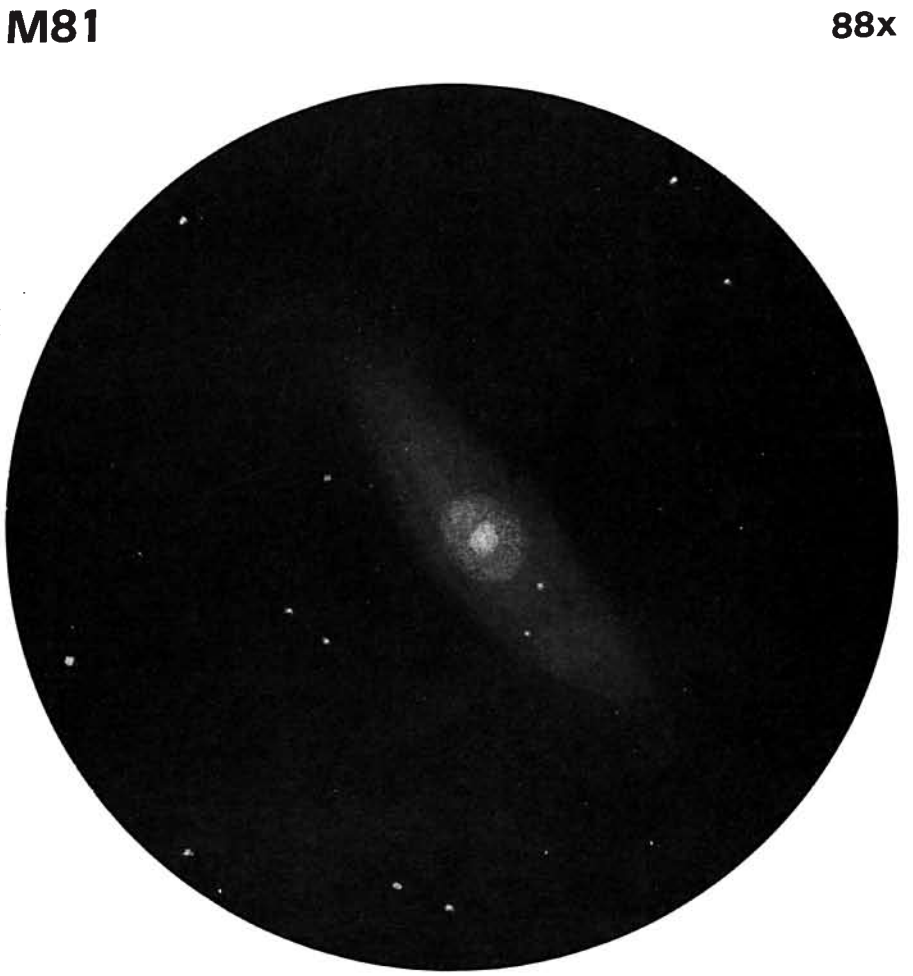
adapt fully in the half hour it takes me to set up.

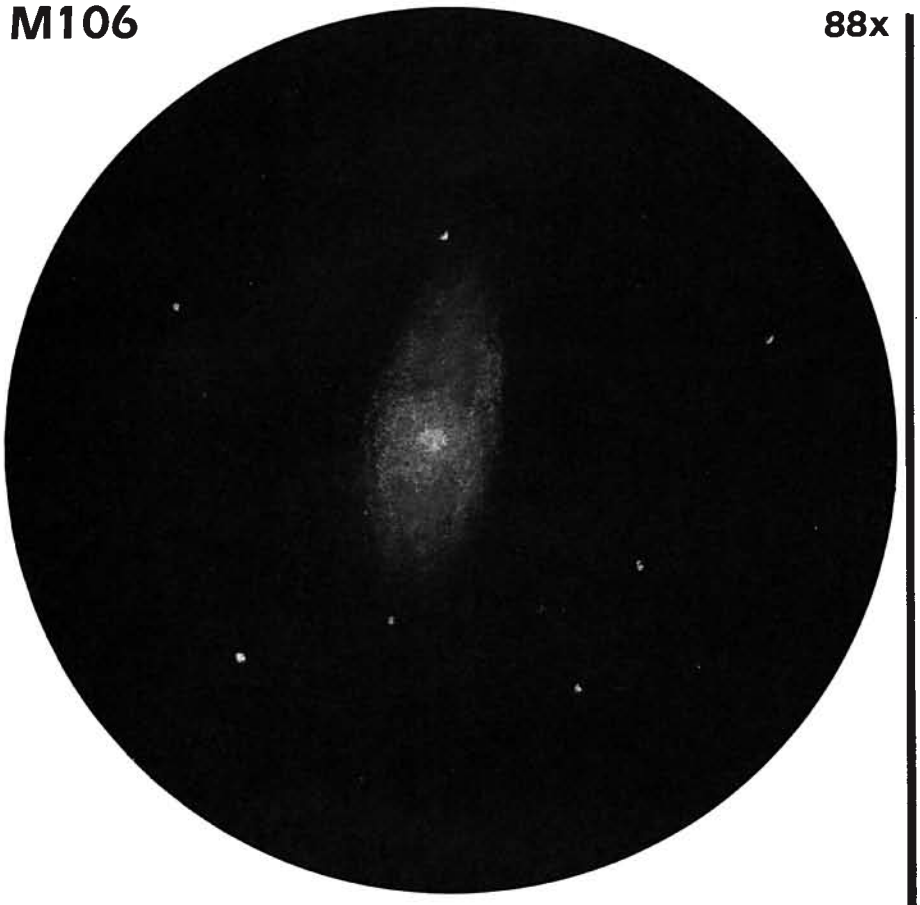
The right finder scope is also critical. I replaced the "issue" finder on my C-11 with an 11x80 that can be used in either straight-through or right-angle modes. The ability to switch to the right-angle mode is extremely helpful when viewing at high northern declinations — without it, I'd be as twisted as a circus contortionist. The 80mm objective brings in lots of detail that makes star-hopping easy. Moreover, used alone it also offers great views of large objects like M31, the Milky Way star clouds, and the Beehive, Coathanger, Double, and Pleiades open clusters.

Another viewing aid is a light pollution filter. I find my Lumicon Deep-Sky Filter as indispensable as the shelter I put up to protect my night vision from the glare of streetlights, house lights, and the occasional passing car. My shelter is essentially two layers of black cloth hung on vinyl-covered wire, supported by electrical metal tubing posts. These are inserted into pipes which I sunk in my front lawn and capped on both ends to prevent them from filling with water.

You'll need a hair dryer and dew cap for those nights when dew or frost fog your corrector plate or lens (this shouldn't be a problem if you have a Newtonian). Don't overlook your finder, either! I made my dew cap out of thick, black poster paper and lined the inside with self-stick black flocked paper; its length is twice the diameter of the corrector plate.

Finally, relax and get comfortable.





Observing is less strenuous when you are seated and more effective when you're relaxed.

When you observe galaxies — even bright ones — use averted vision. Look slightly away from the object in each direction. You may spot something by looking down that you didn't see by looking up or to the right. Similarly, sweeping the scope gently in each direction may also yield added detail. Move your scope slightly using your r.a. and dec. slow-motion controls. Use just the lightest pressure if you have a Dobsonian.

Different eyepieces will also show different aspects of an object. At 165x, the bright spiral NGC 2903 in Leo shows a granular elongated middle. At 311x, however, the central half fills the field and the nuclear region breaks up into interconnected components.

For each galaxy, note the shape, size, and brightness of both the middle and the extended envelope (disk in spirals) surrounding it. Ask yourself: What is the difference in brightness between the middle and the extended portions? Is the change gradual or sudden? Are there density variations within the disk or is it a smooth glow?

To get a sense of an object's angular size, turn off the telescope drive and time the object's drift if you have a stopwatch handy. To determine the field's orientation, shut off the drive and watch the stars drift along. This defines the east-west line, and north and south are perpendicular to it.

What to Get

So much for observing a galaxy — now what do you need to "collect" it? Basically, just pencil and paper. A wire-bound sketch book is most convenient to use and it's good to have both a light and dark pencil — with erasers! A small pencil sharpener will also come in handy. Use a circle template to draw circles representing your eyepiece field. While this is not essential, I have learned from experience that these are very helpful in maintaining the scale and positional relationships of the objects in view. (I presume you already have a dim red light and stand or table to hold your star charts.)

I took up white on black sketching last year. I get black mat board cut into 4″ x 5″ rectangles at a local art supply store. The black side, of course, takes the sketch while the white side is handy for noting the date, sky conditions, eyepiece and filter used, and other data. The size makes the cards easy to store in a small file box. I pre-draw 4″ diameter circles on the cards to save time at the eyepiece.

I prefer to use a white Conte drawing pencil. This pencil is softer and easier to work with than regular white charcoal, graphite, or wax-based pencils. A blending stump is essential for

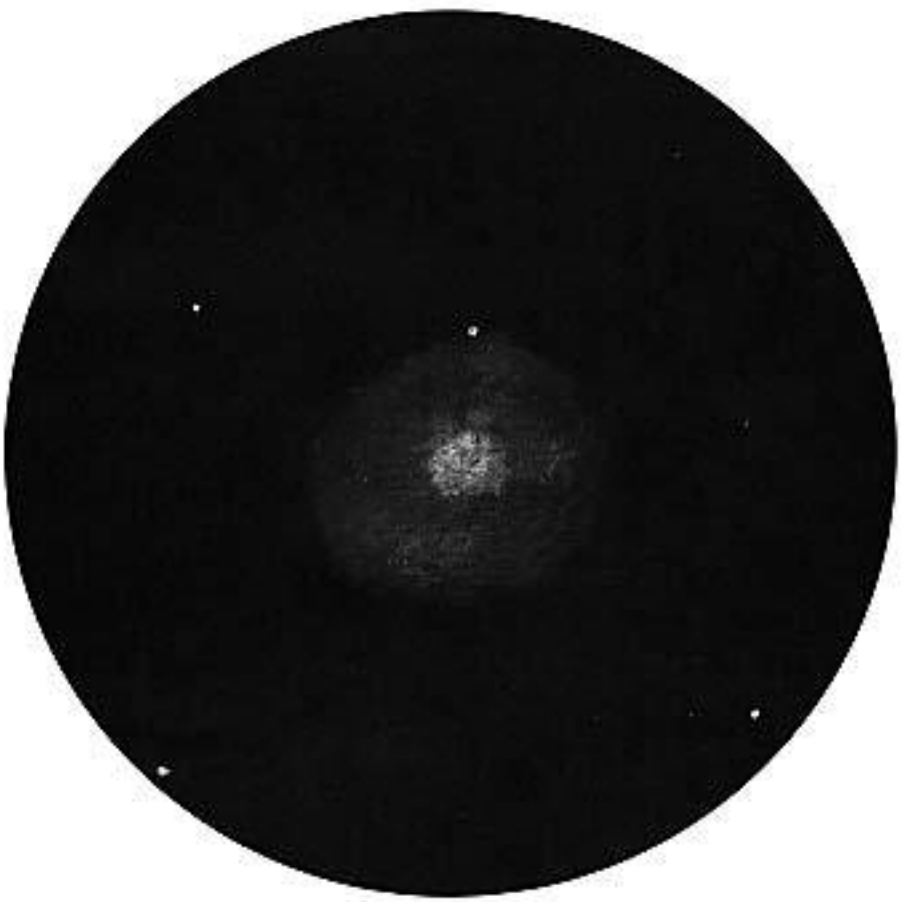
smoothing the galaxy's rough shape into different brightness gradations and portraying the faint outer areas of its disk. A large, soft eraser will correct the inevitable mistakes. To avoid smearing the sketch, use a small paintbrush for removing excess material and erasing debris. Finally, a quick shot of a matte-finish spray fixer will seal and protect your sketch.

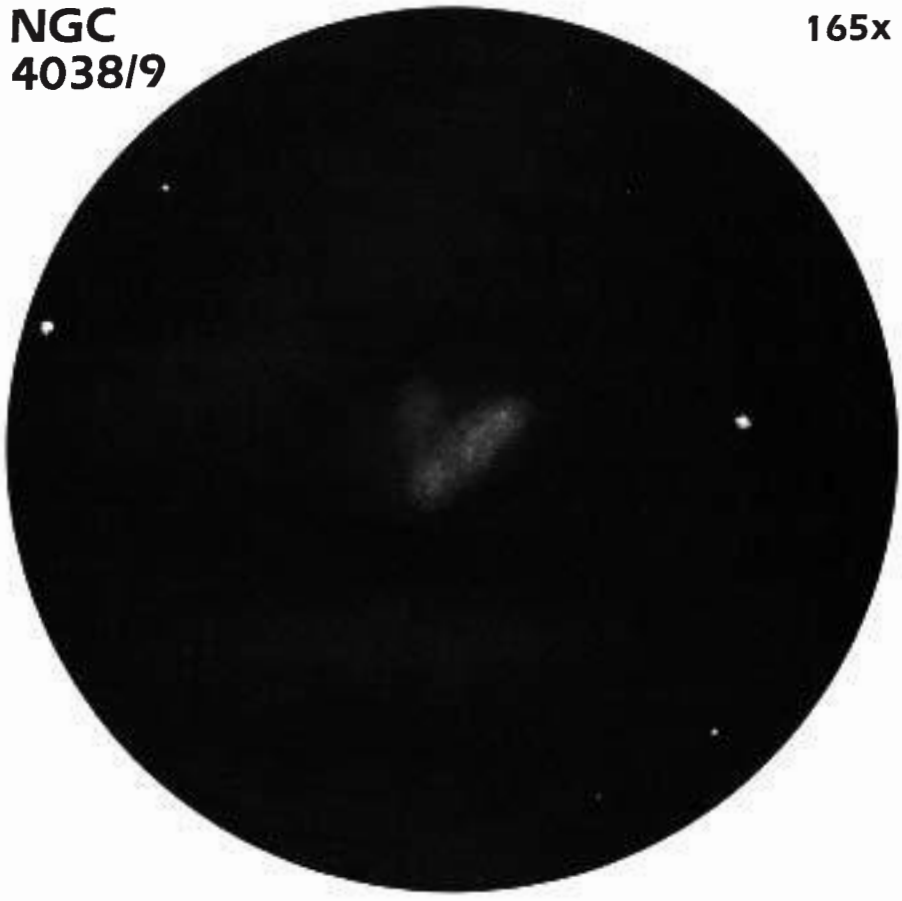
Since the fixer will also darken the sketch, compensate by making your galaxy somewhat brighter than it actually appears. (You may have to do this anyway when sketching faint galaxies if you don't want to have a sketch that can be seen only with averted vision!) All of these supplies are available in an art supply store for under $15.

Sketching Techniques

While you don't have to be an artist to get into sketching, some preliminary exercises won't hurt. One classic suggestion I read somewhere was to practice drawing an egg until your end-product actually looks like one. If you want practice with positional relationships, try drawing double stars.

Ready to start galaxy sketching? Okay, pick a target. No, not M31 or NGC 6946! The former is too big (unless you sketch the view in a 50mm finder) and the latter is too faint. Both lie in complex starfields, besides. Start with something bright, simply structured, and in an area with few field stars. M94 in Canes Venatici is an ideal first subject; M88 in Coma Berenices is too. Both are easily viewable this time of year.





Once you find your subject, study it carefully for a while before putting pencil to paper. Examine the characteristics of the subject itself, and try different eyepieces to determine the best combination of magnification and field size. When you've identified the view you want to capture, observe the relationship of the object to the field stars and the field stars to each other. Now you're ready to draw.

Start any deep-sky sketch by putting down the bright field stars first, working clockwise around the periphery of the field and then into the interior. This establishes the framework on which you'll add the details. Remember to work lightly so that mistakes can be corrected easily. Next, add the majority of the fainter field stars. Don't make your stars too big — keep them points of light. Also, be sure to watch for field drift to avoid distorting your sketch. An r.a. drive is a tremendous aid in this regard. I remember trying to draw M31 in a 6-inch RFT with an alt-azimuth mount. I spent most of my time chasing the galaxy and the end result was atrocious.

For the galaxy itself, use heavy pencil shading for the middle. Soften this with the blending stump, working it outward to form the galaxy's disk. If you're using a graphite pencil for a black-on-white sketch, use your finger as a blending stump. For an edge-on galaxy, draw a heavy line and then soften it with your blending stump or finger. If the object doesn't have a brighter middle, lightly shade the area of the galaxy with a drawing pencil and use the blending stump to get that diffuse look. With the nucleus and the disk completed, add any fine details such as knots or streaks. Use your eraser for dark lanes, and don't forget the faintest field stars — one of them could turn out to be a supernova! Last but not least, take a final look in the eyepiece and compare the view with your sketch. When you're reasonably satisfied, add the galaxy to your collection and move on to your next challenge.

Warning: May be Habit Forming

As your galaxy collection increases, your sense of personal achievement and satisfaction will grow. This spring's "galaxy season" is the ideal time to start. But let me warn you — the more you sketch, the more you'll want to sketch. Observing will never be the same again!

Jay Albert's boyhood fascination with astronomy lay dormant until aroused by his young son and daughter. In 1983, equipped with an 11-inch SCT, Albert began sketching galaxies, and has recorded over 100. He is director of the Amateur Astronomers Association of Princeton, New Jersey.

DEEP SKY OBJECTS IN CENTAURUS

by Jim Barclay

NGC 4945, with its highly-inclined arms and looosely-structured nucleus, appears like a fainter version of NGC 253. Photo by Jim Barclay; 12.5-inch f/6 Newtonian, 1000 ISO film, 45-minute exposure.

The galaxy NGC 5253 offers a bright nucleus and faint outer halo of gas. Photo by Jim Barclay; 12.5-inch f/6 Newtonian, 103a-E emulsion, 60-minute exposure.

Centered on the rich Southern Milky Way, Centaurus contains numerous open clusters, binary stars, galaxies, and nebulae. It also holds the sky's best globular cluster, and the closest star to the Sun.

Background photo: NGC 5102, © Anglo-Australian Telescope Board.

NGC 5102

8-inch f/6 reflector 115x

Sketch by A.J. Crayon

17.5-inch f/4.5 reflector 200x

Sketch by Steve Coe

Centaurus, the legendary half-man, half-horse of Greek mythology, is a fascinating beast for backyard sky observers. It covers an extensive area of sky — some 1060 square degrees — smack dab in the middle of the rich southern Milky Way, and is bounded by the lesser groups of stars Antlia, Carina, Circinus, Crux, Hydra, Lupus, Musca, and Vela. Centaurus is the jewel of the southern sky, containing expansive clouds of bright nebulae and dark dust, the brightest and largest globular star cluster, a peculiar eruptive galaxy, and Proxima Centauri, the closest star to the Sun.

The best deep-sky object in Centaurus is **Omega** (ω) **Centauri** (NGC 5139), the brightest globular cluster in the sky. Omega is so bright (V magnitude 3.7) that it is easily visible to the naked eye and thus, early in the 1600s, earned a Bayer designation as a naked-eye "star." In 1677, Edmond Halley first noticed that Omega was a cluster made up of innumerable stars. It is a globe-shaped collection of perhaps a million stars, and lies 5.5 kiloparsecs away in our Galaxy's halo.

Photographically, Omega measures 36.8′ across — larger than the Full Moon's diameter (and on deep exposures the extreme membership diameter is 90′). Visually, though, you'll probably see it as a uniformly luminous disk about 20′ across and falling off to a mottled haze at the edges. Take a peek at Omega through your binoculars or finder telescope — you'll see a bright, featureless disk of light. A 4- or 6-inch telescope reveals that Omega is elongated roughly east-west, and that it is fairly "loose" (its Shapley concentration class is XIII). The brightest stars in Omega Centauri are around magnitude 14.5, so that a medium sized telescope at high power will resolve individual stars in it.

In describing the great globular, John Herschel stated: "*The noble globular cluster Omega Centauri is beyond all comparison the richest and largest object of its kind in the heavens. The stars are literally innumerable, and as their total light affects the eye hardly more than a star of 4th magnitude, the minuteness of each star may be imagined.*" The 18th century English observer's words still ring true today, 125 years after they were first written. From my observatory in Caloundra, Queensland, using a 12.5-inch reflector, NGC 5139 is oval and its color bluish-white; stars are resolved right down into the core. Steve Coe and A.J. Crayon, observing from Arizona, report that in a 17.5-inch scope at 100x, 5139 is "resolved to the core, while at 135x it is difficult to separate from the background stars."

Only 4½° north of Omega Centauri lies one of the sky's brightest and most curious galaxies — **NGC 5128**. This object is a nearby (4 megaparsecs) peculiar S0 galaxy which consists of a giant spherical halo of stars and gas, crosscut by a broad, detailed dust band. This galaxy has an interesting observational history. Way back in 1849, John Herschel described it as "*two semi-ovals of ellipticity formed nebula appearing to be cut asunder and separated by a broad obscure band parallel to the larger axis of the nebula, in the midst of which a faint streak of light parallel to the sides of the cut appears.*" In 1918, Heber D. Curtis of Lick Observatory classed NGC 5128 among the edgewise spiral nebulae with dark lanes. Four years later, before he uncovered the nature of galaxies, Edwin Hubble thought NGC 5128 was a local nebula. And ten years after that Harlow Shapley included it in his catalogue as an irregular system. We now class NGC 5128 as S0pec.

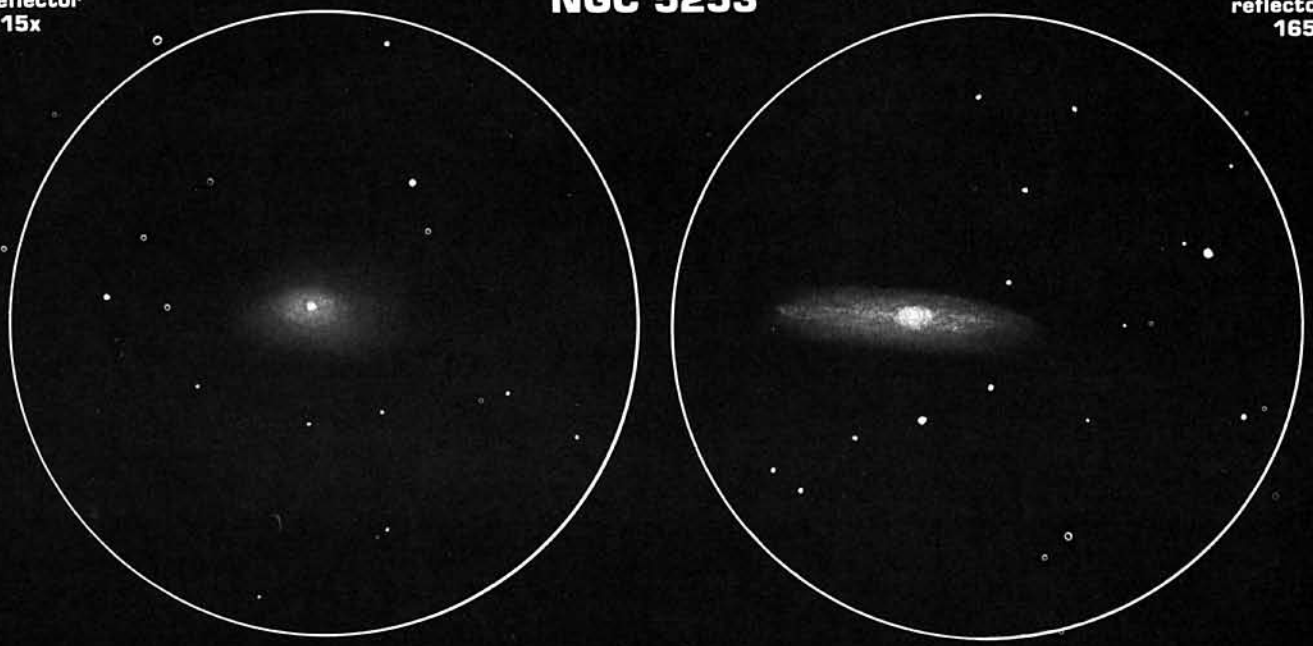
NGC 5128 throws out 1000 times as much radio radiation as the Milky Way, and is known as radio source Centaurus A. A gigantic explosion may have occured inside the nucleus of this galaxy, as it is emitting symmetrical jets of high-energy electrons in much the same manner as M82 in Ursa Major, NGC 1097 in Fornax, and other galaxies. Such systems may house immense black holes in their centers.

NGC 5128 is a bright, easy object for most any telescope. A 4-inch reflector at high power shows a "double nebula" consisting of two crescent-shaped half-moons of light, separated by a dark line. An 8-inch telescope reveals some detail within the bright sections, and shows mottling inside the dark nebulosity running across the galaxy's face. A 17.5-inch reflector at high power shows detailed structure within the dark band — this bright structure represents giant chains of O- and B-type stars involved in "bursts" of star formation. From Arizona, Steve Coe noted that, in a

8-inch f/6 reflector 115x

NGC 5253

17.5-inch f/4.5 reflector 165x



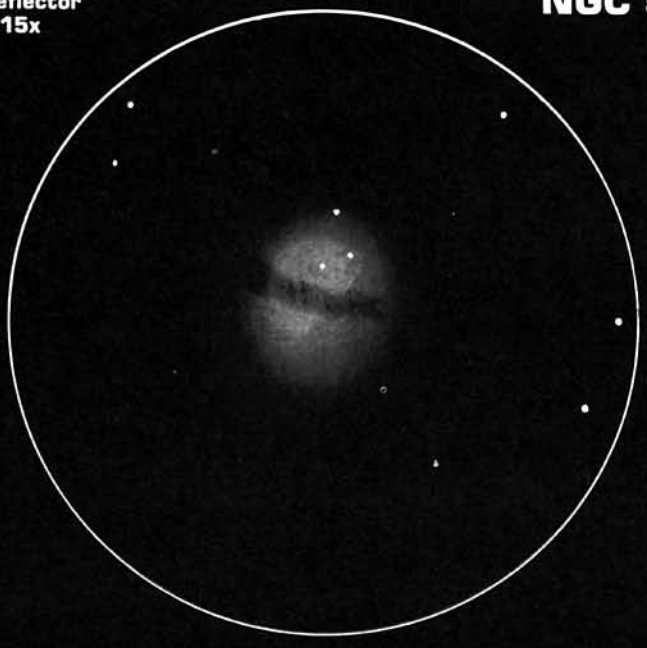
Sketch by A.J. Crayon

Sketch by Steve Coe

ω Centauri, the finest globular cluster in the sky, is a magnificent sight in any telescope. Photo by Jim Barclay; 12.5-inch f/6 Newtonian, 1000 ISO film, 15-minute exposure.

NGC 5128

8-inch f/6
reflector
115x



Sketch by A.J. Crayon

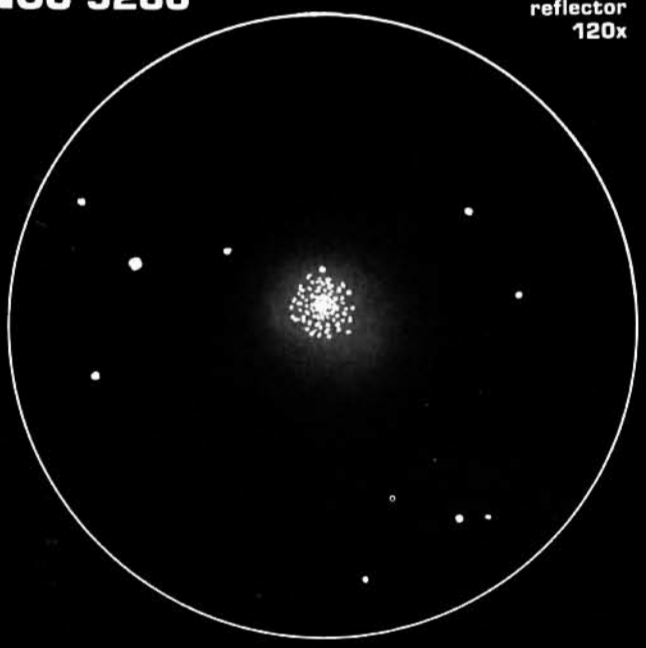
17.5-inch f/4.5
reflector
135x

Sketch by Steve Coe

The peculiar S0 galaxy NGC 5128 (Centaurus A) is the brightest galaxy in Centaurus, and the brightest active galaxy in the whole sky. Photo by David Healy; 14-inch SCT at f/6, hypered TP 2415, 48-minute exposure.

NGC 5286

12.5-inch f/6 reflector 120x



Sketch by Jim Barclay

NGC 5460

8-inch f/6 reflector 80x

Sketch by A.J. Crayon

17.5-incher at 100x to 300x, the "dust band was quite visible, with two stars inside it."

Another fine galaxy in Centaurus is **NGC 4945**, a spindle-shaped barred spiral galaxy resembling NGC 253 in Sculptor. With a blue magnitude of 9.5 and dimensions of 20.0′ x 4.4′, NGC 4945 is one of the largest and brightest galaxies in Centaurus, but its overall surface brightness is pretty low. Try observing it with a wide field ocular on a dark night: you should see a shimmering oval of milky-white light. A high power view with 6-inch or larger scopes will show some mottling in the galaxy's disk, and a tiny, condensed nucleus. With my 12.5-inch scope at 119x, the full outline of NGC 4945 was visible, including a prominent "gap" on one side of the arms. Reports from Arizona from 17.5-inch scope observations mention a diffused nucleus and faint arms — not bad considering that NGC 4945 isn't but a few degrees above their horizon! NGC 4945 lies at the same distance as NGC 5128, belonging to the same group of galaxies. The two galaxies have roughly the same diameter, too.

NGC 5102 is a tightly-wound spiral located near the bright star Iota (ι) Centauri. It measures 9.3′ x 3.5′ across, glows at magnitude 9.6, and appears as a small, bright oval of hazy light in a 2-inch scope. A group of Arizona observers used a 17.5-inch scope to view NGC 5102 from Mount Hopkins, Arizona, the site of the Multiple Mirror Telescope (MMT). They described NGC 5102 as "pretty bright, elongated, and with a bright nucleus. And it reminds us of a miniature M31!" A.J. Crayon used his 8-inch scope and made the following observation: "NGC 5102 is large, almost twice as long as its width. It is gradually brighter in the middle and has a small, dim nucleus." In Queensland, using the 19.5-inch telescope at Alloway, Bundaberg, I saw 5102 as "a bright, small nucleus; lies in a rich starfield; appears similar to M31; no detection of spiral shape; overall contrast is low."

Some 1.9° south-southeast of M83, the great face-on spiral in Hydra, is an irregular/peculiar galaxy designated **NGC 5253**. This strange object can claim host to two bright supernovae over the past 100 years. During the summer of 1895, an eighth magnitude flare was discovered at Harvard University. In late spring 1972, astronomers found an 8.4 magnitude supernova in NGC 5253 from photos made by Charles T. Kowal using the 18-inch Schmidt at Palomar.

Using the 17.5-incher from Mt. Hopkins, Arizona, Steve Coe described NGC 5253 as "pretty bright, elongated, with a much brighter middle . . . 100x gives a superior view. Averted vision shows a dim spiral halo around the bright core." From my site, a 12.5-inch scope showed 5253 as elongated with a starlike nucleus. An extremely wide field — like that given by an RFT — will show M83 and NGC 5253 together. Indeed, NGC 5253 is a member of the M83 group of galaxies, which also includes NGC 4945, NGC 5102, and NGC 5128.

Although not as stunning as Omega, the globular cluster **NGC 5286** — Centaurus' *other* globular — is a telescopic showpiece. It shines at magnitude 7.5 and measures nearly 10 arcminutes across, so that it appears like a tightly compressed ball of hazy light. A 14.5-inch telescope shows partial resolution at the cluster's edges, and reveals a starry background which includes the variable star M Centauri in the same field. Several observers have remarked that NGC 5286 closely resembles M30 in Capricornus.

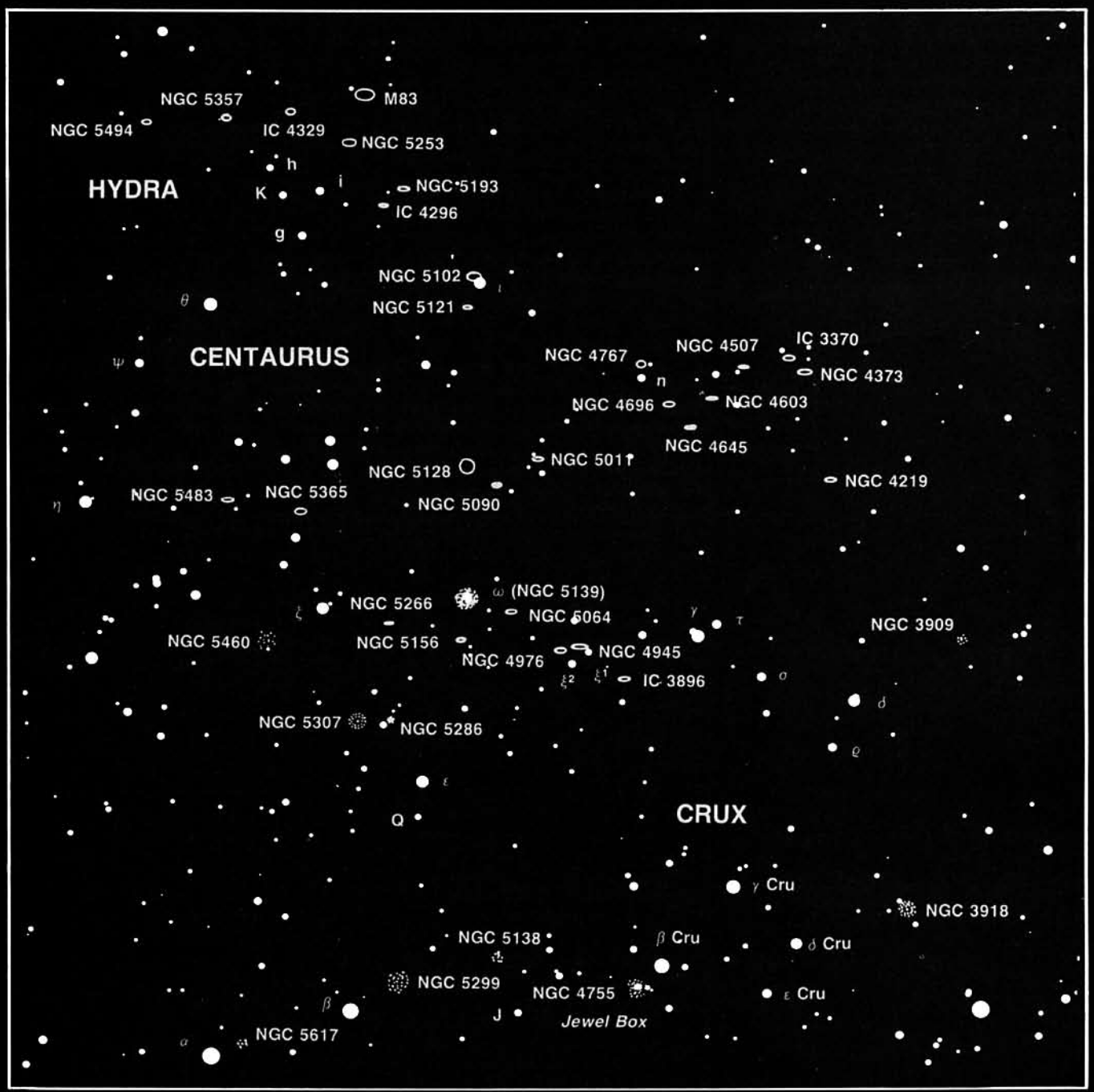
An interesting triple star system is **Alpha** (α) **Centauri**, which at 1.33 parsecs — or about 25 trillion miles — is the closest star system to the Sun. Also called Rigel Kentaurus, Alpha Centauri is the third brightest star in the sky, following Sirius and Canopus. Rigel Kent is one of the finest visual binaries in the heavens — its duplicity was discovered by Father Richaud in Pondicherry, India, in 1689. The two brightest components are a −0.01 magnitude G2 V star (one closely matching the Sun), paired with a magnitude 1.3 K1 V star at a distance of 8.7″ (p.a. 8° in 1944). The primary star measures 1.1 solar diameters, contains 1.1 solar masses, and shines with the light of 1.5 Suns. The secondary spans 1.2 solar diameters, holds 0.9 solar masses, and has the luminosity of 0.4 Suns.

In addition to the secondary, the Alpha Centauri system contains a third member named **Proxima Centauri**. This star is a distant triplet, appearing 132″ away, which corresponds to an actual distance of one trillion miles —

Deep Sky Objects in Centaurus

Type	Designation	R.A.(2000)Dec.	Mag.	Mag.*	B-V	SB	Size	N*	Sp. Type	Sep./Per.	P.A.	Dist.	Lin. Diam.
★²	h4409	11h07.3m −42°38′	5.2	5.5ᵖ, 8.0ᵖ	0.03 ?	—	—	—	—	1.4″	260° (1960)	—	—
E3	NGC 3557	11h09.8m −37°32′	10.4	—	1.0	14.0	4.0′ x 2.7′	—	—	—	—	38 Mpc	44 kpc
★²	I1542	11h25.5m −36°03′	—	5.5, 10.0	—	—	—	—	—	1.3″	120° (1927)	—	—
⊙	NGC 3680	11h25.7m −43°14′	8.6	10...	—	—	11′	26	—	—	—	1.7 kpc	5.5 pc
□	NGC 3699	11h27.8m −59°56′	—	—	—	—	—	—	—	—	—	—	—
□	IC 2872	11h28.4m −62°57′	—	—	—	—	2′ x 2′	—	—	—	—	—	—
★²	Brs 6 (Δ109)	11h28.6m −42°40′	—	5.1, 7.8	−0.03, 0.09	—	—	—	B9V, A5V	13.1″	167° (fixed)	—	—
SA0⁻	NGC 3706	11h29.7m −36°25′	12.3ᴴᶜ	—	—	14.0	2.9′ x 1.9′	—	—	—	—	—	—
□R	IC 2944	11h35.8m −63°01′	—	3.4	—	—	66′ x 36′	—	—	—	—	—	—
⊙	NGC 3766	11h36.4m −61°36′	5.1	8...	—	—	10′	60	—	—	—	500 pc	1.5 pc
⊙	IC 2948	11h38.5m −63°32′	9.0	—	—	—	15′	50	—	—	—	660 pc	2.9 pc
SB(r)a	NGC 3783	11h39.0m −37°45′	12.9ᴴᶜ	—	—	13.9	1.9′ x 1.5′	—	—	—	—	37 Mpc	21 kpc
□R	NGC 3882	11h46.0m −56°22′	—	8.2	—	—	—	—	—	—	—	—	—
⊙	NGC 3909	11h49.5m −48°16′	—	9...	—	—	—	—	—	—	—	—	—
■	NGC 3918	11h50.3m −57°11′	8.4	—	—	—	10″	—	—	—	—	4.4 kpc	—
⊙	NGC 3960 (Mel 108)	11h50.9m −55°42′	9.0	12...	—	—	6′	50	—	—	—	5.3 kpc	9.1 pc
★²	Delta (d)	12h08.4m −50°43′	—	2.5↔2.7, 4.8,6.5	−0.12	—	—	—	B2IVne	68.6″, 16.6″	325° (1913) 227° (1913)	115 pc	—
★²	D (Rmk 14)	12h14.0m −45°43′	5.3	5.6, 6.8	1.82, 1.19	—	—	—	K4IIIab, K2IIIb	2.9″	244° (fixed)	—	—
SA(s)bc	NGC 4219	12h16.4m −43°20′	12.3ᴴᶜ	—	—	14.2	4.5′ x 1.7′	—	—	—	—	—	—
SA(s)c	IC 3253	12h23.7m −34°38′	12.2ᴴᶜ	—	—	13.9	3.3′ x 1.6′	—	—	—	—	—	—
SA0:	NGC 4373	12h25.5m −39°45′	11.0	—	1.1	14.1	3.2′ x 2.3′	—	—	—	—	42 Mpc	39 kpc
E2⁺	IC 3370	12h27.7m −39°21′	11.1	—	1.0	14.2	2.8′ x 2.4′	—	—	—	—	36 Mpc	29 kpc
SAB0(r)	NGC 4507 (New 2)	12h35.6m −39°55′	12.6ᴴᶜ	—	—	14.2	2.3′ x 2.0′	—	—	—	—	—	—
SA(s)c:	NGC 4603	12h41.0m −40°58′	12.1ᴴᶜ	—	—	14.4	3.8′ x 2.5′	—	—	—	—	—	—
★²	Gamma (γ)	12h41.5m −48°58′	—	2.9, 3.0	−0.03, 0.01	—	—	—	B9.5III, A0III	1.5″	84.5°	50 pc	50 AU
E3⁺	NGC 4645	12h44.0m −41°45′	12.8ᴴᶜ	—	—	14.0	2.2′ x 1.5′	—	—	—	—	32 Mpc	21 kpc
SA(s)bc?	NGC 4679	12h47.5m −39°34′	13.0ᴴᶜ	—	—	13.9	2.3′ x 1.2′	—	—	—	—	—	—
E1pec	NGC 4696	12h48.9m −41°18′	10.8	—	1.0	14.4	3.5′ x 3.2′	—	—	—	—	36 Mpc	37 kpc
E5	NGC 4767	12h53.9m −39°43′	12.4ᴴᶜ	—	—	13.8	2.6′ x 1.4′	—	—	—	—	39 Mpc	29 kpc
E1	IC 3896	12h56.6m −50°19′	12.6ᴴᶜ	—	—	14.2	2.2′ x 2.0′	—	—	—	—	—	—
SAB(rs)bc:	NGC 4835	12h58.1m −46°15′	12.5ᴴᶜ	—	—	14.3	3.4′ x 1.0′	—	—	—	—	26 Mpc	26 kpc
⊙	NGC 4852	13h00.1m −59°36′	8.8	10...	—	—	10′	40	—	—	—	1.2 kpc	3.5 pc
E0	NGC 4936	13h04.2m −30°31′	11.3	—	—	13.8	1.9′ x 1.9′	—	—	—	—	41 Mpc	23 kpc
SB(s)cd:spindle	NGC 4945	13h05.3m −49°29′	9.6ᴮ	—	—	14.2	20.0′ x 4.4′	—	—	—	—	5 Mpc	29 kpc
SB(r)ab	NGC 4947	13h05.4m −35°20′	12.5ᴴᶜ	—	—	14.0	2.8′ x 1.7′	—	—	—	—	13 Mpc	11 kpc
★²	f(h4567)	13h06.3m −48°28′	—	4.7, 10.8	−0.15, 0.82	—	—	—	B4IV, K0Vpec	11.4″	79°(1933)	—	—
★²	Xi²(ξ², 128)	13h06.9m −49°54′	—	4.3, 9.4	—	—	—	—	B2IV, F7V	25.1″	100°(fixed)	—	—
E4pec:	NGC 4976	13h08.8m −49°30′	10.2	—	1.0	13.8	4.3′ x 2.6′	—	—	—	—	15 Mpc	19 kpc
E1⁺	NGC 5011	13h12.8m −43°06′	12.6ᴴᶜ	—	—	14.1	2.0′ x 2.0′	—	—	—	—	—	—
SAb:	NGC 5064	13h18.9m −47°55′	13.0ᴴᶜ	—	—	14.1	2.8′ x 1.2′	—	—	—	—	—	—
E2	NGC 5090	13h21.2m −43°44′	12.4ᴴᶜ	—	—	14.4	2.6′ x 2.5′	—	—	—	—	—	—
SA0−	NGC 5102	13h21.9m −36°39′	9.6	—	0.7	14.0	9.3′ x 3.5′	—	—	—	—	3 Mpc	8 kpc
★³	J(Δ133,Fin208)	13h22.6m −0°59′	4.6	5.4, 5.4, 6.2	−0.13, −0.13, 0.01	—	—	—	B3V, B2.5Vn	0.1″, 60″	168° (1959), 343° 1879)	—	—
SA(s)apec	NGC 5121	13h24.8m −37°41′	12.5ᴴᶜ	—	—	14.0	2.3′ x 2.0′	—	—	—	—	—	—
S0pec	NGC 5128	13h25.3m −43°01′	7.0	—	1.0	13.9	18.2′ x 14.5′	—	—	—	—	4 Mpc	21 kpc
●	Omega(ω,NGC 5139)	13h26.8m −47°29′	3.7	14.5ᴴᴮ	0.8	—	36.3′	1M	—	—	—	5.5 kpc	58 pc
⊙	NGC 5138	13h27.3m −59°01′	—	11...	—	—	10′	15	—	—	—	—	—
SB(r)ab	NGC 5156	13h28.7m −48°55′	12.8ᴴᶜ	—	—	14.2	2.1′ x 2.0′	—	—	—	—	—	—
SA(s)c:	NGC 5161	13h29.1m −33°09′	12.0ᴴᶜ	—	—	14.5	5.4′ x 2.3′	—	—	—	—	27 Mpc	43 kpc
SB(rs)b:pec	NGC 5188	13h31.5m −34°47′	12.7ᴴ	—	—	—	—	—	—	—	—	—	—
SB0−pec	NGC 5193	13h31.9m −33°13′	12.6ᴴᶜ	—	—	13.6	1.8′ x 1.6′	—	—	—	—	46 Mpc	24 kpc
E0	IC 4296	13h36.6m −33°58′	10.6	—	1.0	13.1	—	—	—	—	—	46 Mpc	—
Iopec	NGC 5253	13h39.9m −31°39′	10.6	—	0.4	12.9	4.0′ x 1.7′	—	—	—	—	3 Mpc	3 kpc
★²	Q(Δ141)	13h41.7m −54°33′	—	5.5, 7.0	—	—	—	—	—	5.3″	163°(1956)	—	—
SA0⁻:	NGC 5266	13h42.9m −48°11′	12.3ᴴᶜ	—	—	14.2	3.2′ x 2.1′	—	—	—	—	—	—
●	NGC 5286	13h46.2m −51°22′	7.5	16.3ᴴᴮ	0.9	—	9.1′	—	—	—	— 8.7 kpc	23 pc	
⊙	NGC 5281	13h46.6m −62°54′	8.0	10...	—	—	3′	20	—	—	—	1.3 kpc	1.1 pc
S0⁻	IC 4329	13h49.0m −30°18′	11.6	—	1.0	14.2	3.2′ x 1.6′	—	—	—	—	57 Mpc	53 kpc
⊙	NGC 5299	13h50.3m −59°52′	—	—	—	—	30′	—	—	—	—	—	—
■	NGC 5307	13h51.1m −51°13′	12.1	—	—	—	15″ x 10″	—	—	—	—	2.4 kpc	—
★²	N(Δ147,Rmk 18)	13h52.0m −52°49′	—	5.3, 7.7	−0.09	—	—	—	B9V, A3V	18.0″	289°(fixed)	—	—
★²	h(4,Hn51)	13h53.2m −31°56′	—	4.7, 8.4	−0.14, 0.36	—	—	—	B4IV, AM	14.9″	185°(fixed)	—	—
⊙	NGC 5316	13h53.9m −61°52′	8.4	11...	—	—	12′	50	—	—	—	1.6 kpc	5.5 pc
E1	NGC 5357	13h55.9m −30°21′	13.2ᴴ	—	—	—	—	—	—	—	—		
□	NGC 5367	13h57.7m −39°59′	10?	—	—	—	1.3′ x 1.0′	—	—	—	—	—	—
(R)SB0(s)⁻	NGC 5365	13h57.9m −43°57′	12.4ᴴᶜ	—	—	14.4	3.1′ x 2.4′	—	—	—	—	—	—
(R′)SBdm?pec	NGC 5398	14h01.2m −33°04′	12.7ᴴᶜ	—	—	14.0	2.9′ x 1.4′	—	—	—	—	—	—
★²	Beta (β)	14h03.8m −60°22′	—	0.6, 3.8	−0.23	—	—	—	B1III	1.3″	251°(1960)	150 pc	200 AU
E4	NGC 5419	14h03.8m −33°58′	12.4ᴴ	—	—	—	—	—	—	—	—	55 Mpc	—
⊙	NGC 5460	14h07.7m −48°19′	6.3	8...	—	—	30′	25	—	—	—	800 pc	7.3 pc
SA(s)c	NGC 5483	14h10.5m −43°19′	2.1ᴴᶜ	—	—	14.3	3.1′ x 2.8′	—	—	—	—	22 Mpc	20 kpc
LPV	R	14h10.6m −59°55′	—	5.3 11.8	2.04	—	—	—	M5IIev	546.2d	—	300 pc	—
SA(s)c	NGC 5494	14h12.4m −30°40′	12.6ᴴᶜ	—	—	14.0	2.2′ x 2.0′	—	—	—	—	—	—
★³	Hd 228	14h14.9m −57°05′	—	5.1, 12.3, 12.8	−0.08, 2.37, 0.88	—	—	—	B4Vne, M3IV, FN3	33.9″, 36.0″	170° 220° (1913)	—	—
★⁴	Δ159(Rmk 19)	14h22.6m −58°28′	—	4.9, 7.1, 13.5ᵖ, 10.5ᵖ	0.87, 0.40	—	—	68III, F5V	9.3″	20.7″, 45.6″	160° (1931), 255° (1903), 40° (1902)	—	—
⊙	NGC 5617	14h29.7m −60°43′	8.5	8...	—	—	15′	50	—	—	—	1.8 kpc	7.9 pc
⊙	NGC 5662	14h35.2m −56°33′	8.2	9...	—	—	8′	30	—	—	—	1.1 kpc	2.6 pc
★ˢ	Eta (η, α207)	14h35.5m −42°09′	—	2.4	−0.2	—	—	—	B1.5V?ne	—	—	120 pc	675 AU
★³	Alpha (α)	14h39.6m −60°50′	−0.3	−0.01, 1.3, 10.7	0.71, 0.88	—	—	—	G2V, K1V, M5e	8.7″, 132″	8° (1944)	1.33 pc	10,000 AU
★²	Ho 390	14h55.7m −33°51′	—	5.3, 12.5ᵖ	0.04	—	—	—	AOV	24.3″	170° (1922)	—	—
★²	Kappa(κ,I1260)	14h59.2m −42°06′	—	3.1, 11.5ᵖ	−0.20	—	—	B2IV	—	3.9″	82° (1960)	150 pc	570 AU

Column 1: type of object. ★² = double star, ★³ = triple star, ★⁴ = quadruple star, ★ˢ = shell star, LPV = long period variable, ⊙ = open star cluster, ● = globular star cluster, □ = complex nebulosity, □R = reflection nebulosity, ■ = planetary nebula; revised Hubble types given for galaxies; **Column 2**: name in *Revised New General Catalogue*, by J. Sulentic and W. Tifft, and additional lists; **Column 3**: coordinates for epoch 2000.0; **Column 4**: integrated magnitude in V system, or Harvard corrected magnitude if superscript HC; Harvard photographic magnitude if superscript H; **Column 5**: V magnitudes of component or central stars, or magnitude range of cluster stars, or tip of globular cluster's giant branch if superscript HB; **Column 6**: B-V = integrated color; the larger the number, the redder the object. **Column 7**: mean surface brightness in magnitudes per square arcminute; **Column 8**: angular diameter in arcminutes; **Column 9**: number of stars in cluster; **Column 10**: spectral types of component stars; **Column 11**: separation in arcseconds or period in days; **Column 12**: position angle and year measured; **Column 13**: distance in parsecs, kiloparsecs, or megaparsecs; **Column 14**: linear diameter in astronomical units, parsecs, or kiloparsecs. Data for open clusters from G. Lynga, *Catalogue of Open Cluster Data*, 3rd edition. Data for globular clusters from G. Alcaino, *P.A.S.P.*, **89**:491, 1977. Data for galaxies from G. de Vaucouleurs, A. de Vaucouleurs, and H. Corwin, *Second Reference Catalogue of Bright Galaxies*, Univ. Of Texas Press, 1976. Estimated mean surface brightness data by D. Eicher and B. Skiff. Special thanks to Brian Skiff for compiling data.



Centaurus Finder Map

Artwork by David J. Eicher

1/18 of a parsec. The star was discovered by R.T. Innes in 1915, Proxima shines at magnitude 10.7 and is an dM5e type star. It has one of the smallest diameters of any known stars, at about 5% of the Sun (or 40,000 miles). Its luminosity is so low that if placed at the Sun's distance, Proxima's light would equal only 45 Full Moons. The distance between Alpha Centauri and Proxima Centauri is about 10,000 astronomical units, or 930 billion miles.

Rigel Kent's naked-eye "twin" star, **Beta** (β) **Centauri**, is a fine double. Its components shine at magnitudes 0.6 and 3.8, and are separated by a close 1.3″ in p.a. 251° (1960). This scant distance corresponds to an actual separation of only 200 astronomical units, or 18.6 billion miles. Another double star is **Kappa** (κ) **Centauri**, which is composed of magnitude 3.5 and 11.5 stars separated by a more reasonable 3.5″ (in p.a. 82°, 1960). Yet another binary in Centaurus is **Xi² Centauri**, a pair of magnitude 4.3 and 9.4 stars separated by a generous 25.1″ in p.a. 100° (fixed).

These are but a few of the deep-sky wonders awaiting you in the southern constellation Centaurus. See the table on page 28 for a data listing for 81 objects in the constellation; a finder map appears above. Whether or not you can observe Centaurus' galaxies right away, contemplate their many forms, sizes, and types. Here lies a rich hunting ground for galaxies and Milky Way objects — even if you must wait until the Texas Star Party to see them!

Jim Barclay is an avid telescope maker and deep-sky observer living in Queensland, Australia.

DSM Reports

A Visit with Ben Mayer

by David H. Levy

The starry sparkle in his eyes gives away his beginnings — a bright nova in Cygnus, a handful of well-timed photographs — and the understanding that he, a raw beginner in astronomy, had contributed something to science.

His voice rising with excitement as he emphasizes his point, Ben Mayer, the amateur's amateur, has been stumping the country proselytizing the sheer joy of observing — not how we can see the sky, but why we must. "I am not a trained astronomer. I am a beginner and I think it is a lovely thing to be a beginner. And always a beginner. I'll be a beginner on my dying day."

Last year, Ben Mayer delivered the main lecture at Riverside — no, not a lecture, rather a plea to get into observing for the right reasons. Seven days later he talked again at the Texas Star Party. In between? He saw the annular eclipse from the east coast, addressing a different kind of audience on the miracle of the sky. In August, at Stellafane, Dave Eicher and I sat down with him to explore the depth of his feeling for observing:

"We don't compete in astronomy. But how do you become the best lover? How do you become the best amateur? It's by getting into the heart and soul. Doing your best and thinking your best. And trying anything because there are no limitations. As an amateur, you are a blessed individual. You don't have to do anything to satisfy a schedule or a curriculum. You just go at it.

"My curiosity about astronomy dates back to my childhood. I had a normal curiosity — what's out there? Where am I coming from? Where am I going? My father was the first to tell me about Vega and Lyra. But then I didn't have time. There were too many crazy things happening for me to look through telescopes or devote much time to them. It was not until I was much older and had bought this telescope to look at girls that I became hooked on astronomy."

Why do people get into astronomy? What motivates a totally normal, pleasant, everyday person to abandon sanity and lifestyle for the stars? "Many amateurs do crazy things. So when you hear of someone spending thousands of hours at a telescope, it's not crazy to you and it's not crazy to me. But it may be crazy to some. We are all of us a little bit touched. Amateurs have that wonderful element of lunacy. I like the idea that as amateur astronomers we can do unconventional things."

For Ben, as with many of us, the answer lies in the idea of serendipity, an unexpected discovery of the heavens as we are involved in something different.

"I didn't know that you cannot do 'useful work' from a rooftop in West Los Angeles where the light pollution is awful. Actually, it was an automatic camera that took prediscovery photographs of an exploding nova [Nova Cygni 1975]. The camera was photographing the nova while I was asleep in bed in the house below! Not only that, when I had photgraphed it I still didn't know what I had — I developed the film and was looking for meteors. And not seeing any of those telltale trails on the film, *I threw the whole lot into the trash!*

"Astronomy is not a field where you have to know . . . it's a field where you have to feel."

"Now this is the ultimate in stupidity. I never entertained the idea there might be something on the film which I might want to refer back to later. Then I found out. They asked me if I had seen the nova — I didn't even know what a nova was! They had to show it to me. I suddenly realized that this nova was exactly in the area I had photographed all week, and if anything had happened in that week I'd have it on film."

Rescuing the film, Mayer saw for the first time the orderly progress of an exploding star right before his eyes. On film he'd thrown out! He was excited, his family was excited. And the Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts was excited, too. "When can we see the pictures?" Dr. Marsden wanted to know, and Ben's new career was launched.

"The beautiful thing about astronomy is that you can even make a rediscovery. I found Uranus — exactly like William Herschel did — and was so excited to think that I might have really made a discovery. I didn't know what it was. But finally I was told, and of course, was momentarily let down. But my mind had already begun telling me that something so bright must have been discovered already by someone else — the night before, probably. What I didn't know was that somebody had discovered it two centuries before.

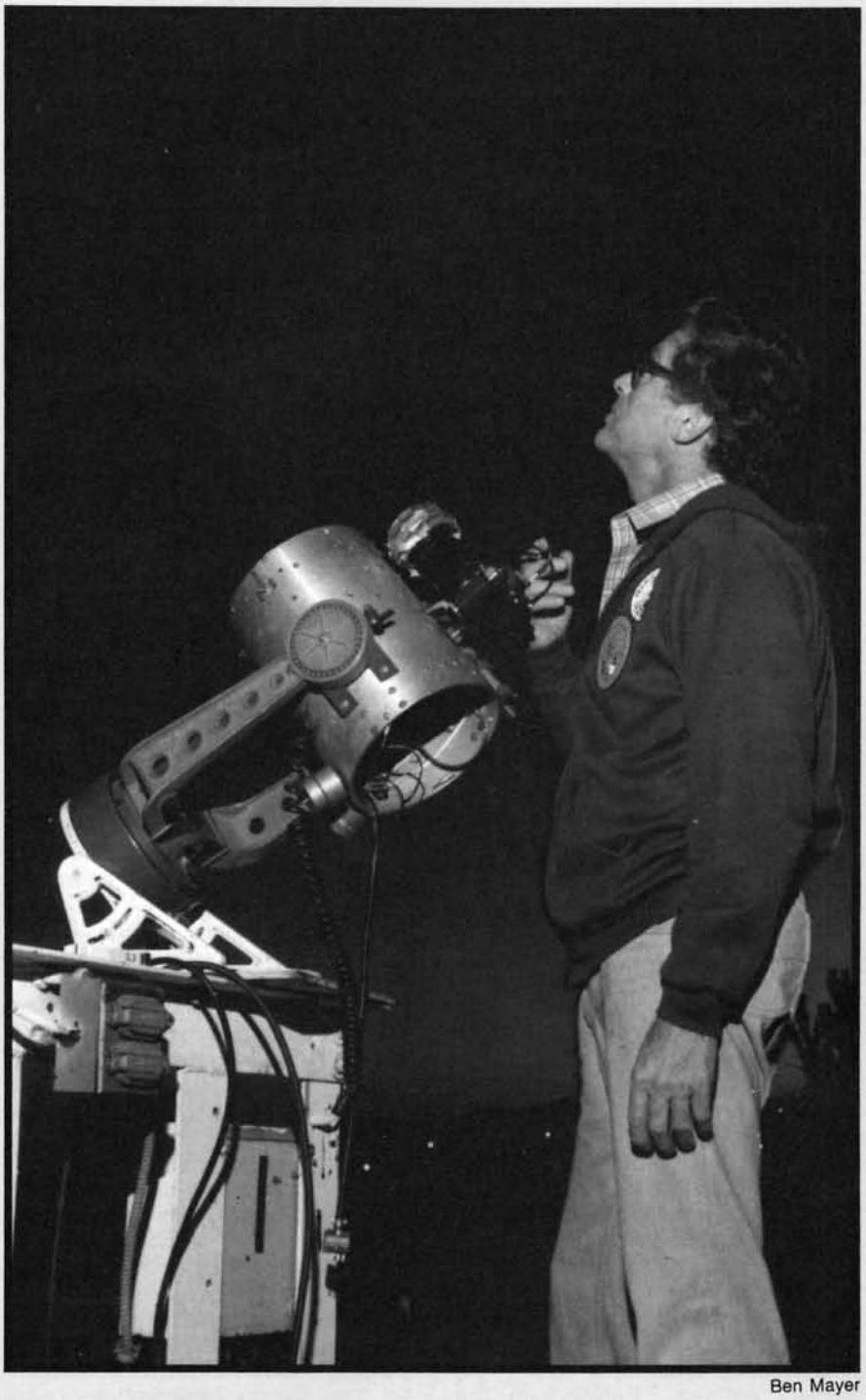
"You discover many things in astronomy. If you learn that William Herschel beat you to the punch by 200 years, you then go read everything you can about him and his planet. Discovery takes many forms. Above all, I've found that I have discovered myself. I have discovered aspects of myself in astronomy I didn't know were there before."

Articulating a feeling with which most of us are familiar, Ben recalls his early sightings of M13: "It was for me a discovery to think that this little smidgen which looked like a star is really a ball of stars. And as I read more about it, I discovered that it is a hundred light-years wide, a hundred light-years high, and a hundred light-years deep. It is a ball of stars containing a million suns.

Andrew Crilly

"If you show that to a person, in addition to showing him the constellation of Hercules, you have opened a magic kingdom. Because then you have opened the whole subject of globular clusters. Which leads to galactic clusters. Which leads to variable stars. And it is endless. This is how I approach astronomy.

"You might say that after you have taken pictures of all the Messier objects, you've done it all. This could be interpreted as a limiting factor, you know. After all, what are you going to do when you have photographed all the Messier objects? Then you *feel* them. The most beautiful thing about



Ben Mayer

astronomy is that the more you look, the more you feel. You may not see that much more, but you sense that there is so much more to do."

Many beginners are put off by the mathematical complexity of astronomy. "But," says Ben, "astronomy is not a field where you need to know. It is a field where you have to feel. This is especially true when you understand that you cannot know very much. We are not allowed to know very much — the limitations are too severe. But a hook in a tackle box will not catch a fish. And once I had found out that you could do meaningful work in astrophotography, I aimed a camera at the sky every possible moment."

Telescope and camera both help us *see* the stars. "We have this wonderful instrument called the human eye at our disposal. You could never build one like it. It is f/1.4 to f/32, always ready to work. It has an automatic computer attached which files data. We can discover new things because we have powerful instruments, but if we further sensitize our minds and souls we can make additional discoveries."

Telescope and camera — both help us see. But the books that we read help us to understand them. "Every time you open a book on astronomy, you stand on the shoulders of giants. That's why you can see so well. You stand on the shoulders of Galileo, of Copernicus, of Kepler, of — well, you name it.

"I want us to think in terms of the high plateau that we have reached and then pause to look back on where we came from. We have risen to such heights because of the Galileos."

In his new book *Starwatch*, Mayer offers a new approach to seeing the stars, using coathangers and cellophane. "I think that *Starwatch* will not soon be out of date because it approaches astronomy through a coathanger. I didn't want it to be a book where you have to have a telescope or even a pair of binoculars. A coathanger will do fine because it allows you to look at an area of the sky — you can slice a chunk out of the sky and study it."

The book offers us some tools we can discover new objects and ideas with. "Once you have gotten hooked on the discovery process, you have two choices: you can make space into a thing of mystery, or into a vehicle for discovery."

Toward the end of our talk, Ben mentioned a feeling that many astronomers, amateur and professional, have — that we are alone in our field, that we must struggle for every inch of national support.

"The United States is my adopted country — best qualified, best equipped to send a probe to Halley's Comet. The French are doing it. The Japanese are doing it. The European consortium is doing it. The Russians are doing it. And the United States is not. That to me is sad beyond words. And worse, this will be remembered. We could have bought 10 Halley probes, even 50. We don't have *one*. We have launched men into space, landed them on the Moon. It gave the nation a purpose. It gave a nation the fulfillment of a dream — not just any dream, but Kennedy's dream. Men can do unbelievable things. And in the same spirit I can tell you that the humblest amateur can do truly important things in astronomy. And sky is free. All you need is motivation."

After we'd finished, Dave Eicher and I walked outside and looked up at the hazy sky. It had been a strange Stellafane weekend, with all combinations of weather from driving rain to crystal clear sky, and now this haze. For a while we didn't say very much. Then we saw Ben and his wife leave the hotel and get into their car. With an enthusiastic wave, they drove off. "I see in my grandson," he had said earlier, "a wonder which is the most gentle of all curiosities. He cannot yet articulate the questions which are taking shape in his lovely little head. I feel so embarrassed when I think I am no longer allowed to say, 'I don't know!' There is such magic in the words, 'I don't know.'"

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The Globulars of Lynx

by Jim Meketa

The NGC "Globular"

J.L.E. Dreyer's *New General Catalogue* (NGC) is probably the best single volume guide to the heavens ever written. In just over 200 pages, it lists 7840 deep sky objects and gives a concise description of each one. These descriptions were made by careful *visual* observers working under the dark skies of the 19th century, and I find them to be remarkably similar to the views I get in my 18-inch Dobsonian. Thus, I was surprised one night to find in it the following description of NGC 2537, located in the constellation of Lynx:

"Globular cluster, pretty bright and pretty large, round and very well resolved, with stars of magnitude 20."

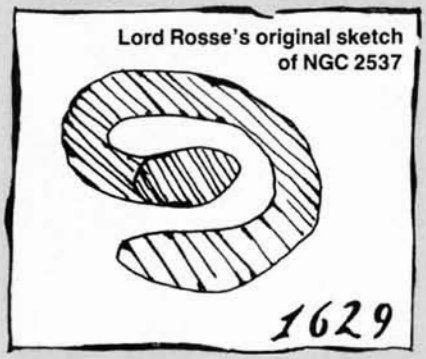
Lynx struck me as an unlikely place to find a globular cluster, since it lies in a piece of barren sky squeezed between Auriga and Ursa Major, on the side of the heavens away from Sagittarius and our Galaxy's core. Since globular clusters are distributed in a roughly spherical halo about the core of the Milky Way, any cluster visible along our line of sight toward Lynx would have to be enormously distant both from us and from the center of our Galaxy.

William and John Herschel were cited by the NGC as the original observers of NGC 2537, and except for the unlikely reference to 20th magnitude stars, their description sounded like that of a typical loose globular. Turning to Sulentic and Tifft's *Revised New General Catalogue* (RNGC), I received a second surprise: NGC 2537 is actually a galaxy. As a deep-sky observer who appreciates the beauty of a well-resolved globular, I immediately wondered how observers as experienced as the Herschels could possibly have mistaken a galaxy for a globular cluster. A compact open cluster maybe, but not a galaxy! The charm of most resolvable globulars lies in the myriad tiny pinpricks of light that dance in and out of view, each a distant Sun. Could the Herschels have been misled by a chance grouping of faint foreground stars set against the unresolved glow of a distant galaxy? It seemed unlikely.

The instruments the Herschels used were the finest research telescopes then in existence, and yet their performance was rarely equal to that of a large backyard reflector today. For example, most of the over 4500 objects found by the Herschels were discovered with their famous "20 foot" reflector. For many years this Newtonian was the largest telescope in the world, with an 18.7-inch speculum metal mirror operating at f/12.8. But since fresh speculum metal reflects only about 60% of visible light, and since the Herschels' simple eyepieces were uncoated, their views in the 20-foot telescope were about as bright as those in a modern 12-inch reflector.

Turning back to the NGC, I noted that William Herschel had recorded NGC 2537 as the 55th object he had found in Class IV. Herschel described his Class IV objects as "Planetary Nebulae: Stars with Burs, with Milky Chevelure, with Short Rays, Remarkable Shapes." — hardly a classification for a well resolved globular. Suspecting that the NGC description could not be the work of William Herschel, I visited the Wellesley College astronomy library to consult their two volume collection of William Herschel's original papers. There I found that William Herschel had discovered NGC 2537 on February 6, 1787, using his 20-foot telescope. He observed it twice at 157x and described it as:

"A pretty bright round nebula, almost



of an even light throughout, approaching to planetary, but ill-defined and a little fainter on the edges, ¾ or 1′ in diameter, proceeds by 1′ a pretty considerable star."

This description was consistent with his planetary nebula classification, but totally at odds with the NGC description as a well-resolved globular cluster. Adding to the confusion, I found a second reference to NGC 2537 by William Herschel, this one dated 1811. In a paper published in the *Philosophical Transactions* of the Royal Society entitled "Relating to the Construction of the Heavens," he argued that NGC 2537 might be a nebula or unresolved star cluster that had progressed from an original diffuse, open state to near final contraction and solidity. In fact, along with six other objects — NGC 2950, NGC 3078, NGC 3310, and NGC 4750 (all galaxies), and NGC 6543 and NGC 6826 (both planetaries) — he offered NGC 2537 as an example of an object for which "a considerable degree of solidity may be inferred." He even provided a drawing of NGC 2537: a small, uniform round patch of light.

Since Herschel had believed that NGC 2537 was a planetary nebula, I suspected that either Lord Rosse or John Herschel must have provided the globular cluster description. The observations made by Lord Rosse and his fellow astronomers with the 72-inch speculum reflector at Birr Castle in Ireland were recorded in the *Scientific Transactions* of the Royal Society of Dublin for 1880. I located a copy of these original papers in the Harvard University library, and was delighted to discover that Lord Rosse, unlike the Herschels, had made drawings of many of the objects he observed, including NGC 2537.

The astronomers at Birr Castle were obviously interested in NGC 2537. They made 20 separate observations from 1849 through 1876, and their descriptions show a gradual evolution over time in their ideas about this unusual object. In his first views in 1849, Lord Rosse found several faint stars sparkling through the nebulosity, and noted that there were dark voids as well. By 1851 the Birr Castle astronomers had traced the nebula's shape in detail, and a note in early 1852 concluded the shape was probably spiral. By 1856 a spiral shape was well established, but only a few embedded stars had been seen. Then in 1858 an observer reported that the southern end was clearly resolved into stars; an idea which seemed to persist until 1876, when a final entry concluded that NGC 2537 was an extremely round globular cluster.

While the Birr Castle astronomers had gradually come to believe after twenty successive observations that NGC 2537 was a globular cluster, John Herschel had reached the same conclusion with a single observation. In 1825 the younger Herschel began a systematic review of the approximately 2000 objects found by his father a generation before. His goals were to verify the original sightings and their positions, and to locate new objects that may have been missed earlier. He used the same 20 foot reflector as his father, and was able to complete his resurvey by early 1833. His results, now known as the Slough Observations, were published in the *Philosophical Transactions* for 1833, and included 500 new nebulae overlooked by William. John's description of NGC 2537, made from a single observation, reads:

"Pretty faint, round, 60″ diameter, very nearly uniformly bright, but hazy at the edges. It is a resolved globular cluster. Being a remarkably fine night, I see the stars; they are 20m; a star 9.10m is 40° south following at a distance of 2′."

It was John Herschel's description then, later summarized in his 1864 *General Catalogue*, that ultimately led to the identification of NGC 2537 as a globular cluster in the NGC. However, I find it surprising that John did not

NGC 2537 and IC 2233

18-inch f/4.5 reflector
129x

sketch by Jim Meketa

Facts About Lynx Objects

NGC 2419

Epoch 2000 coordinates: 7h38.2m, +38°53′
Integrated V magnitude: 10.8
Diameter: 4.1′
Core diameter: 1.8′
Shapley concentration class: II
Spectral type: F5
Number of variables: 38
Distance: 90 kpc
Linear diameter: 107 pc

NGC 2537

Other names: Markarian 86, VV 138, Zwicky 236.035
Type: IB(s)m pec
Epoch 2000 coordinates: 8h13.2m, +46°00′
Integrated V magnitude: 11.7
Mean surface brightness: 13.2
Diameter: 1.7′ x 1.5′
Radial velocity: 438 km/sec
Distance: 5.8 Mpc
Group membership: NGC 2841 group

IC 2233

Other name: Zwicky 236.036
Type: SB(s)d: spindle
Epoch 2000 coordinates: 8h13.9m, +45°45′
Integrated V magnitude: 13.0
Mean surface brightness: 14.5
Diameter: 4.7′ x 0.6′

The Evolution of NGC 2537

1787: *"A pretty bright, round nebula . . . approaching to planetary."* — William Herschel, upon discovery.

1811: *"A considerable degree of solidity may be inferred."* — William Herschel.

1833: *"It is a resolved globular cluster . . . I see the stars: they are 20th magnitude."* — John Herschel.

1849: *"Several stars sparkling through it."* — Lord Rosse.

1851: *"Dark space north and south."* — Lord Rosse.

1856: *"No doubt it is spiral."* — Lord Rosse.

1888: J.L.E. Dreyer copied John Herschel's description from the 1864 *General Catalogue* into his *New General Catalogue.*

1918: *"This is not a cluster, as described in the* N.G.C., *but a bright irregular spiral."* — Heber D. Curtis.

1924: Edwin Hubble discovers that "spiral nebulae" are actually external galaxies.

1973: *"Galaxy, round, high surface brightness, internal structure suspected."* — Jack Sulentic and William Tifft in their *Revised New General Catalogue.*

return repeatedly to NGC 2537 as the Birr Castle astronomers did, especially since his observation completely contradicted the earlier views of his father.

Thus, during the first 89 years after its discovery, NGC 2537 had been classified successively as a planetary nebula, a spiral nebula, and then as a well-resolved globular cluster! NGC 2537 is a very strange galaxy, and it has fooled many observers besides the Herschels and Lord Rosse. Its identification as a globular went unchallenged from 1876 to 1918, when Heber D. Curtis published the results of a photographic survey with the newly-completed 36-inch Crossley reflector at Lick Observatory. His description of NGC 2537, made from a contrasty and grainy photograph, reads:

"This is not a cluster, as described in the N.G.C., but a bright, irregular spiral, 57″ x 44″ in p.a. 167°. There is no true nucleus; a line of bright matter extends along the major axis to the south. It is perhaps a spiral consisting of a single whorl, obliterated at the southern end by occulting matter; the whorl gives it the appearance of an oval ring. It is astonishingly like a planetary in its general form . . . the brightest part is a condensation on the northwest edge."

Note that when Curtis made his photograph, he was unaware that NGC 2537 is a galaxy, he merely realized that it belonged to the class of objects then called "spiral nebulae." It would be another six years before Edwin Hubble would discover that these spirals were not local objects in our Milky Way, but distant Milky Ways in their own right.

Today, NGC 2537 is known as the "Bear Paw" galaxy from its unusual appearance on photographs and in large telescopes. The Russian astronomer Boris Vorontsov-Velyaminov classifies NGC 2537 as a peculiar, distorted spiral, but on good photographs it looks more like a strange assemblage of H II regions and star clouds. These are arranged on a circular arc, broken to the south, and just under 1′ in diameter. The middle is dark, probably from occulting dust clouds, except for a bright spot near the center. In large amateur telescopes the bear paw shape is unmistakable, but in smaller instruments the galaxy merely appears as a mottled 12th magnitude disk. A number of faint foreground stars are scattered across its face, and many of the H II regions contain small bright areas, so it is easier to understand how John Herschel and the astronomers at Birr Castle could have assumed NGC 2537 was a globular, although their "clearly resolved" description sounds like an exaggeration. The modern classification for NGC 2537, published in Gerard de Vaucouleurs' *Second Reference Catalogue of Bright Galaxies*

U.S. Naval Observatory

NGC 2419 photographed with the U.S.N.O. 61-inch reflector.

(RC2), states that it is an IB(s)m peculiar.

NGC 2537 is located about 3½°, or roughly one finder field, northwest of the 4.3 magnitude star 31 Lyncis. Since the galaxy is only 1.7′ in diameter, you will need to use a fairly high power to see the bear paw shape, and this means that a large aperture and good seeing are important. Remember that large telescopes cannot make extended objects such as galaxies appear brighter than in small telescopes, but they *can* make these objects look bigger. Only for point-source objects such as stars is the opposite true; large telescopes do give brighter star images.

In small instruments NGC 2537 will probably look like a large planetary with distinct edges, while in a 12-inch or larger telescope — under very dark skies — the bear paw shape may become visible. If you have access to a really large aperture and clear, dark skies, look for the H II regions and star clouds scattered along the outer edges. At a distance of perhaps 5.8 megaparsecs, the largest of these may be truly huge objects, hundreds of parsecs in diameter.

NGC 2537 has a faint companion galaxy, NGC 2537A, located almost exactly 5′ due east. But a much more interesting object is located 15′ south east; the long needle-shaped galaxy IC 2233. With an integrated magnitude of 13.0, IC 2233 is not a difficult object under dark skies, so it is surprising that it was missed not only by the Herschels but by all later visual observers as well. It was finally discovered photographically by Isaac Roberts at the end of the 19th century, and included in Dreyer's *Second Index Catalogue* in 1905.

IC 2233 appears about 5′ long on photographs, but less than 30″ wide, running nearly north-south. In medium-sized amateur telescopes it is a faint streak, but in larger instruments it resembles a long needle with a faint condensation near the middle. A star lies just off the center on the east side. Photographs show several knots and brighter areas, but there is no hint of the spheroidal bulge that normally accompanies spiral galaxies viewed exactly edge on.

IC 2233 is one of the thinnest galaxies viewable in any telescope. To help find IC 2233 in a small instrument, try rocking the telescope back and forth gently in a east-west direction. The human eye/brain combination is very good at detecting straight lines due to their high contrast, especially if they are moving. With a larger telescope, try increasing the magnification to look for small variations in the galaxy's width and brightness. Can you see any condensations or nuclei?

The RNGC Globular

There is in fact a globular cluster in Lynx, NGC 2419, and William Herschel was the first person to see it although he never recognized its true nature. Neither William in 1788, nor son John in 1833, was able to resolve the cluster NGC 2419, so they classified it instead as a Type I object, or "Bright Nebula." In the first edition of the *New General Catalogue*, Dreyer gives the following condensed description of NGC 2419:

"Pretty bright, pretty large, a little elongated at position angle 90°, and with a very gradually brighter middle."

This is the same description that the Herschels gave many of the external galaxies they observed, being unaware at that time of their true nature. Lord Rosse, who viewed NGC 2419 in 1856, said:

"I can see no star in it, but it strikes me at once as being a distant cluster."

Today we know that Lord Rosse was right. NGC 2419 is indeed an unusually remote globular cluster, located some 90,000 parsecs from the Sun and 98,000 parsecs from the center of the Galaxy. At a distance half again greater than that of the Magellanic Clouds, the brightest stars in NGC 2419 are fainter than 17th magnitude, and hence the cluster may be unresolvable in any amateur telescope.

And yet despite its enormous distance, NGC 2419 is easily visible in a 6-inch telescope — and can even be seen with large binoculars — since it is brighter than an integrated magnitude of 11. It takes a lot of stars to make that much light, and NGC 2419 is estimated to contain several hundred thousand in a sphere about 107 parsecs across. It is an unusually rich and compact cluster, of Shapley Class II, with a very bright, dense nuclear region about 1½′ in diameter. In small telescopes, only the nucleus with its soft, fuzzy edge is visible, but in a large reflector the unresolved halo can sometimes be followed to a diameter of about 3′. But in all telescopes the surface brightness is very low, similar to NGC 6144 in Scorpius or NGC 6760 in Aquila. Don't expect to see much detail — even in an 18-inch scope, only a slight mottling is visible across the diffuse surface.

As of 1977, 38 variable stars had been discovered in NGC 2419, but no definite periods or identifications have been established for any of them. Canadian astronomer Helen Sawyer Hogg notes that five of the variables are suspected of being irregular red stars, with an average variability of about 0.6 magnitude. The remaining variables are almost certainly RR Lyrae stars, with periods of about one-half day. This is a good guess for two reasons. First, over 90% of all variable stars found in globular clusters to date are of the RR Lyrae type. And second, the approximate magnitude ranges of these stars appear to be typical for RR Lyrae variables. For example, several of the variables have amplitudes of about 0.6 magnitude, suggesting a Type 1 variable with a period of 0.5 days or less. Others show a brightness range of just over one magnitude, characteristic of 0.6-day Type II variables. Unfortunately, the average brightness of these variables is only about 19th magnitude, making them far too faint to follow visually. Even photographically they are difficult, which accounts for the lack of detailed information accumulated about the cluster so far.

NGC 2419 is very easy to find, since it lies 7° due north of Castor. Look for two magnitude 7.5 stars running east to west; the fuzzy object on the following end is NGC 2419.

The next time you are admiring an open cluster in Auriga, or the galaxy fields in Ursa Major, swing over to inconspicuous Lynx where an apparently empty sky holds several surprises.

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Double Stars

Halley's Comet, Double Stars, and Astronomical Seeing

by Glenn F. Chaple, Jr.

Just think: within a few short months and after years of fanfare, "you-know-what" finally returns to our night sky. Now, *Deep Sky* is devoted exclusively to deep-sky observing, so Halley's Comet is more or less an off-limits subject. Yours truly, however, has found a sneaky way to weave this celebrated wanderer into this column. What does Halley's Comet have to do with double stars? Read on!

About three years ago, the International Halley Watch — a group led by NASA to coordinate a worldwide effort to obtain and archive data on Halley's Comet during its present apparition — proposed a seeing calibration project. The idea was to create a swift and accurate method for determining the seeing conditions that amateur astronomers would need to make note of when forwarding observations of Halley's Comet to the Halley Watch. And who is better equipped to judge seeing conditions than double star observers?

The project is ostensibly simple. First, view a bright star with the telescope (eyepiece removed) and estimate the size of the blotches seen drifting across the illuminated objective. The blotches are those pesky atmospheric seeing cells that distort starlight and spread the image of the point source star into a disk. Once the seeing cell size is determined, double stars of decreasing separation are observed to determine the scope's resolving power on that night. All results are recorded on a data sheet for ultimate submission to the Halley Watch.

It sounded easy, but there was a hitch. The seeing cells were generally fast moving and irregularly shaped. Estimating their size to any degree of accuracy became a near impossibility. The data forwarded to the Halley Watch by some nine observers — including myself — proved inconclusive. For the Halley Watch, the seeing cell project was a failure. To me, however, it was a rousing success. For the first time, I had observed double stars as part of a serious project. I learned something, too — the larger the cell (8 to 12 inches, or more), the better the seeing.

Many of you could care less about double star projects and seeing cells. Still, you may be interested in the double star sequence I used, since it includes a fine sampling of test pairs — all conveniently located around the Gemini-Cancer region and still visible in the evening sky. Scopes ready? Let's go!

First Stop: Castor

If you want to find out what seeing cells look like, point your scope — without eyepiece — toward Castor and gaze into the eyepiece drawtube. If your aim is true, the objective will be completely illuminated by Castor's pure-white light. Can you see a rippling pattern traversing the objective? These are the seeing cells. The ones I observed were never less than three inches across, so a scope of at least 3-inches' aperture will be needed to reveal the cells in their entirety.

The cell size can be estimated by a comparison with your telescope's objective. You may want to try your own version of the seeing cell project by viewing the cells for a few nights to see how their size relates to your scope's resolving performance. Do you agree with my finding that small cells produce the worst seeing?

Let's turn now to the double stars on our test sequence. By the way, I haven't forgotten about Castor. This fine test pair, featured in the last issue, appears later on our list.

The Sequence

Phi² (ϕ^2) Cancri lies in the northern part of Cancer (2000 position: 8h26.8m, +26°56′) and forms a neat triangle with Phi¹ (ϕ^1) and Chi (χ) Cancri. Its component stars both shine at magnitude 6.3 and are of spectral class A, making Phi² one of those twin systems that gleams hypnotically like a cat's eyes. Set a comfortable 5.2 arcseconds apart at p.a. 218° (1968), the two stars can be split with scopes as small as one-inch in aperture. For telescopes of this modest size, Phi² can be considered a test object; for larger instruments, it's a nice warm-up pair. Under normal conditions, 40x to 60x will separate Phi² nicely.

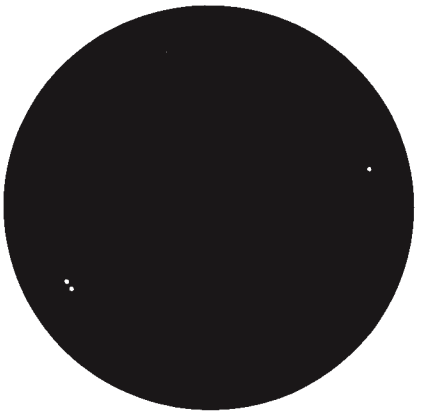
Phi² Cancri is a binary system with awfully slow orbital motion. When first measured by the Russian astronomer F.G.W. Struve a century and a half ago — the star bears the Struve designation Σ1223 — the two stars were 4.6″ apart in p.a. 212°, not too different than their present configuration. I called Phi² a twin system, but several sources give data that indicate a half magnitude difference in brightness. Could one member be slightly variable? Let's keep an eye on this system!

Struve 1177 (Σ1177) is located on the Cancer-Gemini border about 5 degrees west of Phi² Cancri and roughly midway between that star and the first-magnitude star Pollux (2000 position: 8h05.6m, +27°32′). It also lies a scant half degree southeast of Chi Geminorum; those of you who locate sky objects by star-hopping will have little trouble finding this pair of magnitude 6.5 and 7.4 stars. Their separation of 3.5 arcseconds, which along with the position angle of 350° (1968) has remained unchanged since Struve's time, puts them out of the reach of a one-inch scope but within the grasps of a 2-inch on a good night. Use magnifications of 60x to 75x. Less than a degree eastward is Σ1186 — a magnitude 7 and 10 duo whose three arcsecond separation will challenge big-scope owners.

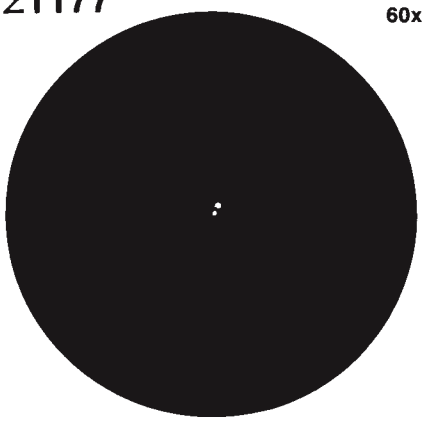
If you read this column in *Deep Sky* 9, you need no introduction to **Castor**, a grand binary system (2000 position: 7h34.6m, +31°53′). If you're a new subscriber to *Deep Sky*, here's the background on Castor: telescopically, Castor is a triple star whose two main components (magnitudes 2.1 and 2.8, separation 2.6″, p.a. 85° in 1985) are widening from a minimum separation of 1.8′ which occurred in the 1960s. Castor's current separation provides a nice test for standard refractors in the

Star	R.A. (2000) Dec.	Mags.	Sep.	P.A.	Year
Σ1037	7h12.8m, +27°14′	7.1,7.1	1.1″	324°	1973
Castor (α Gem)	7h34.6m, +31°53′	2.1,2.8	2.6″	85°	1985
OΣ186	8h03.3m, +26°16′	7.5,8.2	0.9″	73°	1966
Σ1177	8h05.6m, +27°32′	6.5,7.4	3.5″	350°	1968
ζ Cnc	8h12.2m, +17°40′	5.6,5.9	0.7″	239°	1985
π^2 Cnc	8h26.8m, +26°56′	6.3,6.3	5,2″	218°	1868
57 Cnc	8h54.2m, +30°34′	6.0,6.5	1.5″	317°	1968

ϕ^2 Cancri 3-inch reflector 60x



Σ1177 3-inch reflector 60x



Sketches by Glenn F. Chaple, Jr.

50mm (2-inch) to 60mm (2.4-inch) aperture range. Use at least 100x. In just five years, the separation will have increased to 3.0 arcminutes, and it will widen by an additional arcsecond by the year 2000. Castor's value as a test pair may diminish in the years ahead, but its popularity as an easily observable and stunningly beautiful pair will grow.

The third component, of 9th magnitude, lies 72 arcseconds from the main pair. All three of Castor's visual components are spectroscopic binaries, making it a sextuple star system!

The star **57 Cancri** (2000 position: 8h54.2m, +30°34′) is a standard test pair for 3-inch scopes, requiring optimum seeing conditions and a magnification of around 150x for a clean split. 57 Cancri (Σ1291) is located two degrees northeast of Iota (ι) Cancri. Like Phi² Cancri, it seems to be a slow-moving binary system, and has stars shining at magnitudes 6.0 and 6.5 (separation 1.5″, p.a. 317° in 1968). Only the p.a. has changed appreciably since Struve measured 57 Cancri in 1829. Some 56 arcseconds to the south is a third component, of magnitude 9.2.

The spectral classes of the two bright components are G7 and K0, which leads to the promise of some interesting colors. What do you see? Speaking of colors, be sure to check out Iota Cancri (Σ1268; 4.5 and 6.5, 30.5″, 307°, 1958) before leaving the area. This beautiful blue and gold pair has been called the Albireo of spring.

To find **Σ1037 Geminorum**, aim your scope at 47 Geminorum — a 5th magnitude star situated midway between Pollux and Epsilon Geminorum. The Struve double is in the same low-power field as 47 Gem, about a half degree to the northeast (2000 position: 7h12.8m, +27°14′). Σ1037 was the closest pair I split while working on the seeing cell project (magnitudes 7.1 and 7.1, separation 1.1″, p.a. 324° in 1973). I bagged it on three of ten nights. By the way, all of my observations for the project were made with an Odyssey I telescope — a 13.1-inch f/4.5 instrument that I converted to a 5-inch f/12 system by means of an aperture mask. The lowest magnification I needed for Σ1037 was 167x. The current separation of this binary pair (period = 117 years) makes it a nice test for a 4-inch scope.

OΣ186 brings us back to the vicinity of Chi Geminorum, where earlier we found Σ1177. OΣ186 lies at the 2000 position 8h03.3m, +26°16′, some 1.5° south of Chi, and its stars shine at magnitudes 7.5 and 8.2. The separation is 0.9″ in p.a. 73° (1966). This pair was discovered and first measured by F.G.W. Struve's son, Otto, in 1846, and has remained relatively fixed since then. The two are a good test for 6-inch scopes.

Zeta (ζ) **Cancri** is a rapidly-moving binary pair with an orbital period of about 60 years. Its 2000 position is 8h12.2m, +17°40′. The stars shine at magnitudes 5.6 and 5.9 and are separated by 0.7″ in p.a. 239° (1985). Right now, the two are about as close together as they can get — a stern test for 8-inch telescopes. A magnification of at least 300x is in order here!

Accompanying this interesting binary is a third star, magnitude 6.0, placed 5.7″ eastward. Viewed with a small telescope, this star joins the unresolved main pair to create a striking double star. This is what Tobias Mayer saw when he discovered (ζ) Cancri's duplicity in 1756. The close binary was uncovered by William Herschel 25 years later.

All three component stars are essentially similar to our Sun in spectral class, brightness, and mass. The system is about 70 light-years away.

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Double Takes: Special thanks to Steve Coe and the Phoenix-based Saguaro Astronomy Club for honoring me with their first award certificate for double stars. The certificate is presented to observers who notch all double stars on a list prepared by the S.A.C. and based on the "top double stars" series run in this column during 1983.

If your astronomy club doesn't have an awards program that includes a special category for double star observing, why not set one up? There's no better way to motivate your fellow club members into observing these often-overlooked sky objects.

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Variable Stars

A Cornucopia of Spring Variables

by David H. Levy

What kinds of variables are the most useful to observe? It depends on what you want. Right now, the cataclysmics are the "in" thing for scientific study. Their possible X-ray emissions, and their, utter unpredictability, make watching them scientifically productive. If the answer were that easy, however, we could simply forget about the thousands of other variables that need observations, and which are not cataclysmics. Many of these are long period, or Mira-type, stars — objects that deserve careful observation.

There's a limit to what amateurs can do in astronomy. I've tried to explain this to many people who tell me they want to get into amateur astronomy and "play professional." But that's an attitude that limits their work to only those objects most useful to the advance of science. More important, it also flies in the face of what we are into amateur astronomy for. We should choose our variable stars for a number of reasons, only one of which is value to contemporary professional research. Another reason is the future, a concern for the basic need to keep as many variables as possible under observation at all times, whether or not such stars are currently under intense professional scrutiny.

Take R Leonis, for example. It's a star already examined in this column, it's well observed, and the professionals are not lining up right now to get data on it. But several years ago I observed this "typical" long-period variable stop its upward swing in brightness for almost a month. Then, as if it had realized it was behind schedule, it suddenly jumped in magnitude, reaching its maximum only a few days behind

schedule. Right now, scientists show little interest in R Leo. But some day *someone* will, and it's very important that complete light curves be available when they do.

The word "amateur" has its root in the latin verb *amare*, "to love." By definition, we don't have to spend half our time begging for cash from funding agencies, or telescope time from allocation committees. We use our own telescopes, have as much time as we want — and we get our kudos when we supply some useful information. No one cares if we fail. In the game of astronomy, we can't lose for we are not seen as the major players. That means we are free to pursue whatever variable happens to strike our fancy, cover it for months or years, and just *see what happens*. When scientific attention someday comes to our variable, we'll have all the good data it needs. And there is always the possibility that our amateur observatories will someday uncover a major peculiarity in a star that invites professional attention.

Okay, enough tub-thumping! This spring, let's look at a cornucopia of variables, choose whatever strikes our fancy, and get on with it! We'll start with 095814 **RY Leonis**, a long-period variable that's quite easy to find. Simply go about two degrees southwest of Regulus and there you are. With the aid of the AAVSO's "b" chart you should have no trouble finding the star and with the other charts you should have fun estimating it. Its maximum of 8.7 magnitude is easy to catch, and you won't need too much aperture to follow it through the normal 11.5 magnitude minimum. Its period (155 days) is relatively short, which means you can observe its entire cycle of variation over a five-month stretch.

Nearby is 093934 **R Leo Minoris**, a reddish long-period variable with an easy 7.0 magnitude maximum. Near the border of Leo and Leo Minor, this variable, the first to be discovered in Leo Minor, is so simple to find that you'll wonder why you haven't been observing it from infancy. It lies less than one degree to the southeast of 6th magnitude 13 Leonis and varies almost 6 magnitudes in just a few days over a year.

Name	Range	Period
RY Leonis	8.5↔11....	155d
R Leo Minoris	6.3↔13....	372d
V Bootis	7.0↔11.3	258d
R Cor Bor	5.6↔14.8	Irr
T Cor Bor	2.3↔10	—
X Herculis	6.3↔7.5	95:d
g Herculis	4.7↔6.0	70d
RR Cor Bor	7.1↔8.6	61d
X Leonis	11.5↔15....	Irr
Z Cam	9.9↔14.3	Irr

Now let's move east into Bootes, where one of the brightest long-period variables shines forth. 142539 **V Bootis** varies through a leisurely 260 day period, from a maximum of 7.5 to a minimum of 10.7. Only a degree northwest of 3rd magnitude γ Bootis, V Boo is also a cinch to locate. Its behavior is not, however, very predictable. Some years ago it simply stopped varying, and then it abruptly resumed its cycle. Every observation of this incompletely understood star is a small contribution to science. What are you waiting for? Although the AAVSO offers a full set of charts for this unique variable, the "b" chart is all you should ever need.

From Bootes we can inch over to Corona Borealis, whose semicircle of stars stand guard over one of the most interesting variables in the entire sky. **R Coronae Borealis** was the first star to be discovered as variable in Corona, by E. Pigott in 1795. (Pigott also discovered the variability of η Aql and R Sct.) And what a variable! The chances are that when you first see this star, it will be close to its maximum of 5.9; in fact, as I write this, a few months before you read it, R CrB is shining at the limit of naked-eye visibility. But its cycle is completely irregular; I have no idea what brightness it will offer the night you first greet it. This star behaves as a recurring nova in reverse. Instead of resting at minimum and then unexpectedly leaping to maximum, this star's "rest state" is its maximum from which it plunges 8 magnitudes to minimum. How long are its maxima? In the 1920s and 30s it enjoyed almost 10 *years* at maximum; other times it has stayed up for only a few months.

If a recurring inverse nova isn't enough, Corona Borealis also offers a fine example of what we call a recurring nova as well. Meet **T Coronae Borealis**, a nova that flared suddenly in May 1866. Not to be outdone by the attention given its rival R, T presented an encore in February 1946 when it flared again, increasing almost 8 magnitudes in brightness. Will T Coronae perform every 80 years like some cosmic Ol' Faithful? With just two outbursts and the intervening period to go on, such a conclusion is extremely risky. Therefore, no matter how hopeless it sounds, I suggest that once each clear night when Corona is visible you go out and turn your telescope to the field of T, just to make sure it is still approximately 10th magnitude. Remember an outburst comes very suddenly, and a single "off night" could mean you missed the party.

From long-period variables to eruptive stars in both directions, let's explore some of the easy-to-find but hard-to-observe semiregular variables. Many of these are physically huge, bright red stars that are easily seen in binoculars. 155947 **X Herculis**, 162542 **g Herculis**, and 153378 **RR Coronae Borealis** all offer good examples of what these stars can do — you don't get enormous variations (ranges rarely exceed a magnitude and a half), but these stars possess relatively short periods. The problem is that neither their "periods" nor their ranges are constant.

A semiregular may show little or no variation at all over a period longer than its nominal. Another problem is that these stars are red and bright, which means that the dread Purkinje effect can hurt the accuracy of your estimates. Use quick glances rather than leisurely stares to avoid the red buildup on your retina. But here's another tip: don't look at these stars when the Moon is bright! Moonlight scatters lots of blue light all over the sky, which will interfere mightily with how you perceive the brightnesses of these red stars. These binocular variables are not as easy as their brightness leads you to believe.

Now let's go back to where we began, to Leo and R Leonis. This time we're not going to observe R, but instead look in on a different star quite close to it: 094512 **X Leonis**, a difficult but worthwhile example of a dwarf nova. When this star reaches maximum, it is barely visible in an 8-inch. Its usual state at minimum is so faint (16th magnitude) that you'll need at least a 14-incher to find it. But so what? Many deep-sky observers have large Dobsonian instruments capable of finding most objects in the *NGC*. Why not use your special resources to go after some faint variables too? X Leo is an easy find, so it won't take too much of your time. In fact, you can squeeze it in between a nice look at M65/M66 and that welcome cup of hot chocolate that awaits you when your session is over. And on the night that X erupts, your friends will be able to see it too, with their 8-inch telescopes that easily can capture a 12th magnitude speck of light.

One final suggestion: try going north to Camelopardalis, where a very unusual dwarf nova, 081473 **Z Camelopardali**, shines at 13th magnitude (minimum) or 9.6 magnitude (maximum) — or perhaps somewhere in between. Occasionally this dwarf nova decides, on its way down from a maximum, that it is tired of playing nova and just sits there, around 11th magnitude, for weeks, months, or (in the late 1970s) even years.

Spring is indeed a time for variables. Some have more current scientific value than others, but all these mentioned here are worth watching. Have fun!

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Scanning the Literature

October-December 1984

by Brian Skiff

A comprehensive review of the most distant reaches of the Milky Way was presented by Bruce Carney at the 1984 summer meeting of the Astronomical Society of the Pacific. The text of this talk appears in the November 1984 issue of the *Publications* of the Astronomical Society of the Pacific (*P.A.S.P.*) as "Probing the Outer Galactic Halo" (**96**:841). The current high interest in the Galaxy beyond about 25 kiloparsecs from the center has been generated in part by observations suggesting that much of the mass of the Galaxy lies in its outermost reaches, and by an ongoing search for the oldest stars in the Galaxy. As a start, Carney provides a census of the objects we can study to find out about the galactic halo. The most obvious of these are, of course, distant globular clusters such as NGC 2419 and NGC 7006. Dwarf spheroidal galaxies, RR Lyrae stars, and luminous high-velocity stars also come under scrutiny. All of these should contain — or be — the oldest and most metal-poor stars in the Galaxy, and by studying them, we may be able to find out about conditions that existed during the formation of the Galaxy. Yet high proportions of metals are found in some outer halo globulars, and studies of the dwarf galaxies indicate they are only half the age (about 7 billion years) of the Galaxy as a whole (perhaps 16 to 18 billion years).

The paper includes a discussion of the Galaxy's extent and mass (current estimates are in the range of at least 100 kiloparsecs diameter and 5×10^{11} solar masses); a metallicity gradient among stars from the center outward (there is some evidence for a small decline in heavy elements with increasing distance, but there is much scatter in the data); the search for extremely metal-poor (extremely old) stars having only one-ten thousandth of the Sun's metal abundance (disappointingly few yet found); and the possibility of a "second parameter" other than the amount of these heavier elements that indicates age (the existence and nature of this parameter is elusive at present).

Among the constituents of the outer galactic halo are two faint globular clusters which have been observed by William Harris and Sidney van den Bergh ("The Distant Globular Clusters Palomar 14 and Palomar 15," *Astronomical Journal* (*A.J.*) **89**:1816, December). The authors appropriately used 5-meter Palomar plates to make star counts and create photometry of the cluster stars. They also found the previously published position for Pal 15 to be several arcminutes in error — enough to put the cluster nearly out of the field of the 5-meter telescope. They give 16h57.3m, −00°28.5′ for Pal 15's epoch 1950 coordinates.

U.S. Naval Observatory

NGC 2419 in Lynx: *"high interest in the Galaxy beyond 25 kpc."*

The star counts suggest apparent diameters of about 5′ for Pal 14 and 8′ for Pal 15. Dynamical model-fitting gives "tidal" diameters of 8.2′ and 9.6′, the diameters at which forces outside the cluster (star clouds, the Galaxy itself) trying to tear stars away from the cluster is just balanced by the mutual gravitation of cluster stars. But Harris and van den Bergh point out that such "tidal limits" probably are not as meaningful for these distant clusters as for those near the galactic center, where the stronger external forces make the boundary smaller and more sharply defined. In any case the fringes of these clusters are very poor in stars.

From their color-magnitude diagram, the authors derive respective distances of 70 kpc and about 60 kpc from the center of the Milky Way. Combined with the apparent sizes from the star counts, the diameters of the clusters are a whopping 180 and 200 parsecs! ("Inner halo" globulars are typically 30 parsecs across.) Palomar 15 also has the largest core and lowest central density of any known globular. It has been suggested that these large, distant clusters form a transition between normal globulars and the dwarf spheriodal galaxies. But while these clusters are very large, the typical dwarf galaxy is at least five times larger, besides being much brighter and more massive. From the photometry, the integrated apparent V magnitudes are estimated to be about 14.8 and 14.2, leading to absolute magnitudes of −4.7 and −5.4 for Pal 14 and Pal 15.

In their conclusion, Harris and van den Bergh remark: *"The principal lesson to be learned from our present brief study may be that even in the farthest visible reaches of the halo, an amazingly varied range of cluster-formation processes seems to have taken place . . . . We are still far from understanding this subsystem of the Galactic halo."*

Among other globular cluster studies of interest to observers are two papers containing measures of stars around several poorly studied objects. The first is "Photoelectric Sequences Near Nine Galactic Globular Clusters" by Martha L. Hazen-Liller (*A.J.* **89**:1551, October). V magnitudes and B-V colors are given for stars around NGC 6139, NGC 6453, NGC 6469, NGC 6569, NGC 6642, and NGC 6717. Each sequence of stars (ranging from V mag. 11 to about 15) is identified on a photograph. These are interesting clusters visually. For instance, NGC 6453 is a tiny object on the western fringe of the naked-eye open cluster Messier 7 in Scorpius; NGC 6717, also very small, lies only a few arcminutes from the 4th magnitude star ν^2 Sagittarri.

Gonzalo Alcaino and William Liller provide measures for four more clusters in "Photoelectric UBVRI Sequences in the Region of the Galactic Globular Clusters NGC 1261, NGC 3201, NGC

4590, NGC 5139 (ω Cen)" (*A.J.* **89**:1712, November). These are more southerly clusters than in the first paper, but all except NGC 1261 are accessible for viewing from the southern United States. The sequence stars are identified in very nice photographs of each cluster.

Photometric studies of two southern open clusters have been published recently. The broad region of stars north of NGC 6231 in Scorpius known as Trumpler 24 (*a.k.a.* Harvard 12 on the Skalnate Pleso and Tirion atlases) was examined by A. Heske and H.J. Wendker ("UBV Photometry of Tr 24 and Its Relation to Sco OB1," *Astronomy & Astrophysics Supplements* **57**:205, August). The astronomers observed 280 stars in the region with the 0.6m telescope at La Silla, Chile. The cluster has been generally considered to be at the same distance as the well-studied cluster NGC 6231, which in turn is considered to be the nucleus of the association called Scorpius OB1. However, the distances to NGC 6231 and Sco OB1 are known to differ by several hundred parsecs. In the present

David Healy

Trumpler 24 (center) and nebulosity.

study, the color-magnitude diagram indicates a distance of 2.3 kiloparsecs, in accordance with the distance of the association. According to the authors, NGC 6231 is a foreground object at 1.6 to 1.7 kiloparsecs, and cannot be the nucleus of the association.

Below V magnitude 11, the Tr 24 cluster stars appear above the main sequence, which the authors interpret as pre-main-sequence T Tauri stars like those in other very young clusters. They also note a condensed subcluster of these stars. But no gas or dust seems associated, as is usual for these "just-turned-on" stars.

Thorough coverage of one of the showpieces of the southern sky is presented by J. Dachs and D. Kaiser in "UBV Photometry of the Southern Galactic Cluster NGC 4755 = κ Crucis" (*Ast. & Ap. Suppl.* **58**:411, November). Photoelectric measures of 86 stars were used to calibrate photographic photometry of an additional 550 stars, providing the most comprehensive study yet of this bright open cluster. From the color-magnitude diagram, the authors find a distance of 2.3 kiloparsecs, an age of around 10 million years, and 200 probable members brighter than V magnitude 16.0. Star counts show the cluster to be 10.2′ (or 6.8 parsecs) in diameter. Among the brightest members are six supergiants — mostly blue. But one red star is also present. The group also contains three variable Be stars and at least one Cepheid-type variable. An excellent set of photos identifies all the measured stars.

In 1962 Beverly Lynds published a catalogue of dark nebulae covering the northern two-thirds of the Milky Way, based on inspection of the Palomar Observatory *Sky Survey*. Until recently there has been no comparable list for the southern sky. J.V. Feitzinger and J.A. Stuwe compiled a list to fill the southern gap from plates taken with the European Southern Observatory's 1-meter Schmidt and the 1.2-meter United Kingdom Schmidt ("Catalogue of Dark Nebulae and Globules For Galactic Longitudes 240 to 360 Degrees," *Ast. & Ap. Suppl.* **58**:365, November). An intricate schematic map shows the outlines of about 500 dark clouds and over 300 globules. Accurate positions, opacities, and an identification cross-index are given in a table.

An interesting northern nebula has been studied by a group of University of Texas astronomers ("Infrared and Millimeter-Wave Observations of the Sharpless 156 Molecular Cloud," Marshall Joy, Neal J. Evans II, Paul M. Harvey, and Bruce Wilking; *Astrophysical Journal* **284**:161, September 1).

Martin C. Germano

IC 1470: *large molecular cloud.*

Sharpless 156, also known as IC 1470, is a bright H II region in Cepheus lying at a distance of about 5 kiloparsecs. The 2.5′ diameter nebula is illuminated by hot O and B stars partly dimmed by dust in the cloud. The observations by this group in the millimeter-wave carbon monoxide emission lines revealed a large molecular cloud surrounding the nebula extending for 20′ (or about 30 parsecs) — no trace of it is evident at visible wavelengths. Infrared thermal emission sources in the cloud are evidently associated with newly formed stars. At least one of these is a "protostar" or prestellar object; another of the sources is a small cluster including an M giant or supergiant.

As star formation occurs in most molecular clouds, the process seems to propagate from a single site, that event setting off a chain reaction of star formation in adjacent regions. Such is thought to be the case in Orion's Belt and Sword, where progressively younger stars are found from north to south. Similarly, in the Lagoon Nebula, the associated cluster appears to be the first result of star formation, continuing in the bright nebula, which may be thought of as a "blister" eating its way into a molecular cloud behind the cluster. But in IC 1470, the star-forming regions are isolated, not related to a single initial event, and may even have begun at different times.

Another unusual feature is the presence of the luminous M star. An evolved star like this is normally found with older star clusters, and its occurence here is an enigma — though the star could be in the foreground and appear to be projected on the group of very young stars.

A good resolution test for small telescopes is ζ Aquarii, a pair of 4th magnitude stars currently separated by 1.73″ in p.a. 212°. The motion of the two stars is slow, but they have been observed long enough to derive a reliable orbit. Though it has been calculated several times in the past, W.D. Heintz gives improved elements based on recent measures in "The Triple Star Zeta Aquarii" (*Ap. J.* **284**:806, September 15). Triple star? Yes: the measures of the pair (which extend back to 1781) show a systematic variation, attributed to a close, faint companion to the A component. For the wider pair, Heintz gives a period of 760 years, which he suggests is good to better than +40 years. The very close star to the A component orbits once in about 16 years. Though it has been at computed separations of over 0.5″ in the past, the star is probably near magnitude 11, and has not been confirmed either visually or by speckle interferometry.

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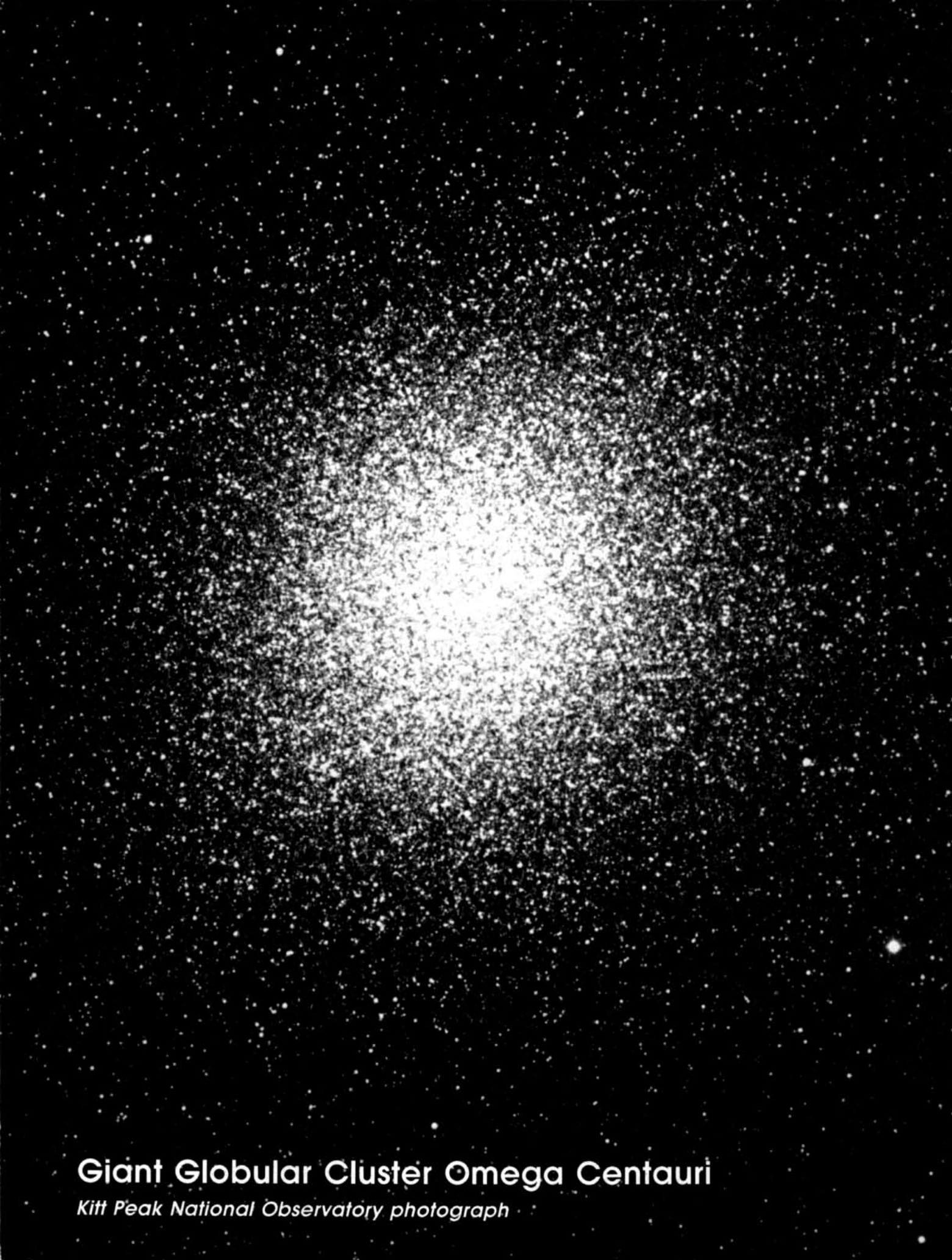

Giant Globular Cluster Omega Centauri

Kitt Peak National Observatory photograph